Modification Comment Tracking Log

August 20, 2011

SUBJECT: Sampling and Analysis Plan (SAP) Enbridge Energy, Limited Partnership, Line 6B Incident, Marshall, Michigan, November 11, 2010.

The Department of Environmental Quality (DEQ), Remediation Division and Water Resources Division have reviewed the subject work plan. Based upon our review of same and pursuant to Paragraph 7.8 of the Administrative Consent Order and Partial Settlement Agreement entered between the parties on November 1, 2010, the DEQ approves the plan with the following modifications:

Item	**MDEQ Modification**
1.	**Narrative** List of Acronyms – This document incorrectly references the Quality Assurance Plan (QAP) throughout the document. Please modify all references to the Quality Assurance Project Plan (QAPP) which was submitted to DEQ on November 11, 2010.
Date	**Enbridge Response**
8/26/11	Text has been modified to reflect MDEQ comments. The recent Approved QAPP submittal of 8/19/2011 has also been added.

Item	**MDEQ Modification**
2.	**Narrative** Section 1.0 Introduction - The SAP is being developed pursuant to Paragraph 7.1(b) of the Consent Order, not 7.1(a) as listed in the SAP. Please correct this statement.
Date	**Enbridge Response**
8/26/11	Text has been modified to reflect MDEQ comments.

Item	**MDEQ Modification**
3.	**Narrative** Section 1.1 Overview of Field Activities – Include groundwater monitoring as part of the continued ongoing monitoring activities.
Date	**Enbridge Response**
8/26/11	Text has been modified to reflect MDEQ comments.

Item	**MDEQ Modification**
4.	**Narrative** Section 3.2.1 Field Log Books, Pages 8 – 9: In the bulleted list of items for daily field book entries, include: • For “field observations” (i.e., including but not limited to visible oil or oil sheen).
Date	**Enbridge Response**
8/26/11	Text has been modified to reflect MDEQ comments.

Item	MDEQ Modification
5.	**Narrative** Section 3.2.1 Field Log Books, Pages 8 – 9: In the bulleted list of items for daily field book entries, include: • Add dissolved oxygen in the next bullet that describes what parameters to measure (pg 9).
Date	**Enbridge Response**
8/26/11	Text has been modified to reflect MDEQ comments.

Item	MDEQ Modification
6.	**Narrative** Section 3.2.1 Field Log Books, Pages 8 – 9: In the bulleted list of items for daily field book entries, include: • Add a bullet to identify the number and location of split samples collected and the name/agency of the collector.
Date	**Enbridge Response**
8/26/11	Text has been modified to reflect MDEQ comments.

Item	MDEQ Modification
7.	**Narrative** Section 5.0 Investigative Derived Waste Management (1st paragraph, 4th sentence) – modify to indicate that the material will be disposed of at an appropriately licensed disposal facility.
Date	**Enbridge Response**
8/26/11	Text has been modified to reflect MDEQ comments.

Item	MDEQ Modification
8.	**Narrative** Section 5.0 Investigative Derived Waste Management (2nd paragraph) – Modify to reflect this is an acceptable practice where the IDW materials are known to be un-impacted. The first sentence erroneously implies this is acceptable where IDWs are "expected" to be un-impacted.
Date	**Enbridge Response**
8/26/11	Text has been modified to reflect MDEQ comments.

Item	MDEQ Modification
9.	**Narrative** Section 6.0 References - Please include the Consent Order as a citation in this section as referenced in the Introduction.
Date	**Enbridge Response**
8/26/11	Text has been modified to reflect MDEQ comments.

Item	MDEQ Modification
10.	**Narrative** Table 2. Sample Nomenclature - add “split samples” to the nomenclature list.
Date	**Enbridge Response**
8/26/11	Text has been modified to reflect MDEQ comments.

Item	MDEQ Modification
11.	**Appendix A** Include provisions for DEQ approval of any modifications to SOPs prior to implementation of work activities that use modified SOPs.
Date	**Enbridge Response**
8/26/11	Modifications to SOPs will be addressed in task specific Work Plans or other form of documentation (Field Change Order or similar) prior to implementation of field activities.

Item	MDEQ Modification
12.	**Appendix A** Include language that any deviation from the SOPs will be documented in field records AND be disclosed in the final submitted reports.
Date	**Enbridge Response**
8/26/11	Text has been modified to reflect MDEQ comments.

Item	MDEQ Modification
13.	**Appendix A** SOP Document Log Table – delete redundant SOP EN-012. If a second revision is appropriate, explain how the SOPs are different and the controls that will be implemented to avoid field confusion of which SOP to use.
Date	**Enbridge Response**
8/26/11	Table has been modified to reflect MDEQ comments.

Item	MDEQ Modification
14.	**Appendix A** SOP: EN-001, EN-002 and EN-003 • Section 3.0 Personnel Qualifications – All personnel should have appropriate OSHA training if working on sites with possible exposure to hazardous materials.
Date	**Enbridge Response**
8/26/11	Text has been modified to reflect MDEQ comments. Note SOP numbers have changed from SOP EN-001, 002, and 003 to SOP EN-301, 302, and 303.

Item	MDEQ Modification
15.	**<u>Appendix A</u>** SOP: EN-001, EN-002 and EN-003 • Figure 3 Boring Log – Include field screen results/observations and note sample collection locations/intervals.
Date	**Enbridge Response**
8/26/11	Field Screen results/observations and sample collection locations/intervals will be included on the Boring Log. SOP EN-301, 302, and 303 have been modified to include this information.

Item	MDEQ Modification
16.	**<u>Appendix A</u>** SOP: EN-003 Subsurface Soil Sampling by Sonic Drilling • Paragraph 3, page 2 - DEQ experience with sonic drilling sample recovery has shown that multiple cobble/boulder layers or cobble/boulder layers greater than 2 to 3 feet may hamper sample recovery but in very few instances has it caused premature refusal of the sampling tool.
Date	**Enbridge Response**
8/26/11	Comment has been noted.

Item	MDEQ Modification
17.	**<u>Appendix A</u>** SOP: EN-003 Subsurface Soil Sampling by Sonic Drilling • Section 1.2 General Principles (Paragraph 2) – Correct reference to Figure 1 which is an example of a Boring Log rather than a sketch of the sampling tool as indicated.
Date	**Enbridge Response**
8/26/11	Text of SOP EN-303 (formerly SOP EN-003) has been modified to reflect MDEQ comments.

Item	MDEQ Modification
18.	**<u>Appendix A</u>** SOP: EN-003 Subsurface Soil Sampling by Sonic Drilling • Pages 3 through 12 Of SOP EN-003 - are incorrectly titled EN-0023.
Date	**Enbridge Response**
8/26/11	Formatting has been revised.

Item	MDEQ Modification
19.	**<u>Appendix A</u>** SOP: EN-005 Monitoring Well Construction • Section 3.0 Personnel Qualifications – All personnel should have 40 hour OSHA training if working on sites with possible exposure to uncontrolled releases of hazardous materials.
Date	**Enbridge Response**
8/26/11	Text has been modified to reflect MDEQ comments.

Item	MDEQ Modification
20.	**<u>Appendix A</u>** SOP: EN-005 Monitoring Well Construction • Section 5.2.2 Well Construction – include the end cap on the well screen.
Date	**Enbridge Response**
8/26/11	Text has been modified to reflect MDEQ comments in SOP EN-401 (Monitoring Well Construction and Installation), Section 6.2.2.

Item	MDEQ Modification
21.	**<u>Appendix A</u>** SOP: EN-005 Monitoring Well Construction • Section 5.2.4 Bentonite Seal Installation – Modify to indicate that extreme care will be undertaken to avoid advancement of bore holes through confining layers. If it becomes necessary to advance bore holes through confining layers, an outer casing should be set in the confining layer, grouted in place, and the integrity of the seal should be verified before continued advancement of the bore hole through the confining layer.
Date	**Enbridge Response**
8/26/11	Text has been modified to reflect DEQ comments (See Section 6.2.4)

Item	MDEQ Modification
22.	**<u>Appendix A</u>** SOP: EN-005 Monitoring Well Construction • Section 5.2.5 Annular Grout Seal Installation – bentonite chips and/or pellets should be hydrated with potable water after placement in the annular space.
Date	**Enbridge Response**
8/26/11	Text has been modified to reflect DEQ comments.

Item	MDEQ Modification
23.	**<u>Appendix A</u>** SOP: EN-005 Monitoring Well Construction • Section 5.2 – modify to indicate how the annulus will be completed from grade to 3 feet below grade.
Date	**Enbridge Response**
8/26/11	Section 6.2.5 of SOP EN-401 modified to have the grout/chips extend from the bentonite seal to the bottom of the concrete pad for the pro casing.

Item	MDEQ Modification
24.	**<u>Appendix A</u>** SOP: EN-005 Monitoring Well Construction • Section 7.0 Quality Control and Quality Assurance (last bullet) – modify to include provisions to document/record the quantity of fluids/water added during installation of bore holes or wells.
Date	**Enbridge Response**
8/26/11	Added another bullet to SOP EN-401 Section 7.0 to address measurement of introduced fluids with gauge or manual measurement.

Item	MDEQ Modification
25.	**<u>Appendix A</u>** SOP: EN-005 Monitoring Well Construction • Section 9.0 Appendix-Glossary – Centralizers were not mentioned in the SOP, therefore are not necessary to include here.
Date	**Enbridge Response**
8/26/11	Reference to centralizers has been deleted from SOP EN-401 as requested.

Item	MDEQ Modification
26.	**<u>Appendix A</u>** SOP: EN-006 Monitoring Well Development • Section 1.0 Scope & Methods Summary (second to last paragraph) – modify to reflect that well development is not the removal of a specified volume of water, rather it involves the removal of water up until the well produces water free of sediments. This may be independent of a specified volume of water.
Date	**Enbridge Response**
8/26/11	Referenced paragraph has been modified to reflect MDEQ comments in SOP EN-402.

Item	MDEQ Modification
27.	**<u>Appendix A</u>** SOP: EN-006 Monitoring Well Development • Section 6.0 Records Management – include provisions to record the volume of water removed from each well.
Date	**Enbridge Response**
8/26/11	Referenced Section has been modified to include MDEQ comment in SOP EN-402.

Item	MDEQ Modification
28.	**Appendix A** SOP: EN-006 Monitoring Well Development • Section 9.0 Glossary – Several items listed in the glossary were not mentioned in the SOP.
Date	**Enbridge Response**
8/26/11	Glossary has been removed from SOP EN-402.

Item	MDEQ Modification
29.	**Appendix A** SOP: EN-008 Water Level Measurements • Section 2.0 Interferences (Paragraph 2) – modify to reflect that one to ten minutes may not be sufficient for water levels to stabilize to atmospheric pressure in wells. This will be site or well dependent.
Date	**Enbridge Response**
8/26/11	Referenced Section has been modified to include MDEQ comment in SOP EN-403.

Item	MDEQ Modification
30.	**Appendix A** SOP: EN-010 Low Flow Groundwater Sampling – • Section 4.0 Equipment & Supplies – include well keys, road box (flush mount) keys, bladders (if bladder pump is used), compressed gas or air compressor for bladder pump.
Date	**Enbridge Response**
8/26/11	Additional equipment and supplies have been added to SOP EN-404.

Item	MDEQ Modification
31.	**Appendix A** SOP: EN-010 Low Flow Groundwater Sampling – • Section 5.6.2 and 5.6.3 – modify to indicate pumps should be lowered into the well until the pump intake is centered in the center of the saturated portion of the well screen.
Date	**Enbridge Response**
8/26/11	Text has been modified for Sections 6.6.2 and 6.6.3 of SOP EN-404 to state pump inlet centered in middle of saturated well screen.

Item	MDEQ Modification
32.	**Appendix A** SOP: EN-010 Low Flow Groundwater Sampling – • Section 5.7.3 Down Well Pumps – correct erroneous reference to Section 7.6.3, the correct reference should be Section 5.6.
Date	**Enbridge Response**
8/26/11	Reference has been corrected within SOP EN-404.

Item	MDEQ Modification
33.	**<u>Appendix A</u>** SOP: EN-012 Surface Water and Sediment Sample Collection • Section 6.0 Equipment and Supplies – modify to include a sampling device in the bulleted list along with a short list of sample device(s) that may be applicable.
Date	**Enbridge Response**
8/26/11	Section 5.0 of SOP EN-201 has been modified to include MDEQ comment.

Item	MDEQ Modification
34.	**<u>Appendix A</u>** SOP: EN-012 Surface Water and Sediment Sample Collection • Section 6.0 Equipment and Supplies – modify to include other sampling paraphernalia that may be used like a sample bottle holder, waders, etc.
Date	**Enbridge Response**
8/26/11	Section 5.0 of SOP EN-201 has been modified to include MDEQ comment.

Item	MDEQ Modification
35.	**<u>Appendix A</u>** SOP: EN-012 Surface Water and Sediment Sample Collection • Under Section 7.2 Surface Water Sampling (pg 7 of 14) - include a sentence that no air bubbles are to remain in sample containers collected for VOC analyses. If air bubbles are captured in the container, the sample should be collected again.
Date	**Enbridge Response**
8/26/11	Section 6.3 of SOP EN-201 has been modified to include MDEQ comment. This is standard practice for any VOC water sample.

Item	MDEQ Modification
36.	**<u>Appendix A</u>** SOP: EN-012 Surface Water and Sediment Sample Collection • Under Section 7.2 Surface Water Sampling (pg 8 of 14) - include field observations for presence and/or absence of oil or oil sheen.
Date	**Enbridge Response**
8/26/11	Section 6.2 of SOP EN-201 has been modified to include MDEQ comment.

Item	MDEQ Modification
37.	**<u>Appendix A</u>** SOP: EN-012 Surface Water and Sediment Sample Collection • Section 7.3 Shallow Sediment Sampling (Page 9, paragraph 1, 1st sentence) – revise the incomplete sentence.
Date	**Enbridge Response**
8/26/11	Comment is no longer applicable due to rewrite of SOP EN-202.

Item	MDEQ Modification
38.	**<u>Appendix A</u>** SOP: EN-012 Surface Water and Sediment Sample Collection • Include a sampling method for collecting sediment cores in deeper water situations.
Date	**Enbridge Response**
8/26/11	SOP EN-201 was modified to specify the use of extension rods or a gravity slide hammer.

Item	MDEQ Modification
39.	**<u>Appendix A</u>** SOP: EN-030 Investigative Derived Waste Management • Section 4.0 Equipment and Supplies - Include drum(s) and ring notching tool in the list of bulleted items.
Date	**Enbridge Response**
8/26/11	Requested information was added to SOP EN-106.

Item	MDEQ Modification
40.	**<u>Appendix A</u>** SOP: EN-030 Investigative Derived Waste Management • Section 5.3.4 Labeling – include provisions to label all wastes.
Date	**Enbridge Response**
8/26/11	Upon receipt of the sample characterization analyses, final labeling of the drums will occur in accordance with applicable State and Federal requirements and Enbridge policy.

Item	MDEQ Modification
41.	**<u>Appendix B</u>** Section 3.3 Sample Parameters – modify the list of analytes to include all of the chemical constituents of the crude oil that were released or are likely to become contaminants of concern during degradation/weathering.
Date	**Enbridge Response**
8/26/11	It is proposed that the analyte list for potable water sampling remain consistent with the requirements of the potable well sampling program being conducted under the SAP developed and implemented for the U.S. EPA.

Item	MDEQ Modification
42.	**<u>Appendix C</u>** 1.0 Introduction, • Page 1, paragraph 2 – Correct the spelling of the EPA personnel in this paragraph.
Date	**Enbridge Response**
8/26/11	Text has been modified to reflect MDEQ comments.

Item	MDEQ Modification
43.	**<u>Appendix C</u>** 1.0 Introduction, • Page 1, paragraph 2, last sentence – Please revise the grammatical error(s) to reflect the intended meaning of the sentence.
Date	**Enbridge Response**
8/26/11	Text has been modified to reflect MDEQ comments.

Item	MDEQ Modification
44.	**<u>Appendix C</u>** • Section 2.1 Sample Location and Frequency (page 2, 1st sentence) – modify to state that sample locations are shown on all nine figures and not just Figure 1 as referenced. In addition, modify the table to label it as Table 1.
Date	**Enbridge Response**
	Text has been modified to reflect MDEQ comments.

Item	MDEQ Modification
45.	**<u>Appendix C</u>** • Section 2.3 Sample Analysis – modify the list of analytes to include all of the chemical constituents of the crude oil that were released or are likely to become contaminants of concern during degradation/weathering.
Date	**Enbridge Response**
8/26/11	The analyte list for the surface water and sediment sampling program has been edited to match the Standard Analyte List as defined on Table A2-2 of the QAPP.

Approved

Enbridge Line 6B MP 608
Marshall, MI Pipeline Release

Sampling and Analysis Plan (SAP)

Prepared for Michigan Department of Environmental Quality

Enbridge Energy, Limited Partnership

Submitted: November 11, 2010

Approved: August 30, 2011

Approved

TABLES

ATTACHMENTS

Approved

LIST OF ACRONYMS

COC	chain of custody
DQO	data quality objectives
Enbridge	Enbridge Energy, Limited Partnership
HASP	Health and Safety Plan
IDW	Investigation derived waste
Line 6B	The pipeline owned by Enbridge Energy, Limited Partnership that runs just south of Marshall, Michigan
MDEQ	Michigan Department of Environmental Quality
Order	Administrative Consent Order And Partial Settlement Agreement entered *In the Matter of Enbridge Energy Partners, L.P., and Enbridge Energy, Limited Partnership*, proceedings under the Michigan Natural Resources and Environmental Protection Act, 1994 PA 451, as amended, MCL 324.101 et seq. signed November 1, 2010
MP	mile post
PPE	Personal Protective Equipment
QAPP	Quality Assurance Project Plan
RRD	Remediation and Redevelopment Division of MDEQ
SAP	Sampling and Analysis Plan
SCAT	Shoreline Cleanup Assessment Technique
SOP	Standard Operating Procedure
U.S. EPA	United States Environmental Protection Agency
U.S. EPA SAP	Sampling and Analysis Plan approved for work directed by the U.S. EPA

1.0 INTRODUCTION

The Administrative Consent Order and Partial Settlement Agreement entered *In The Matter of Enbridge Energy Partners, L.P., and Enbridge Energy, Limited Partnership,* proceedings under the Michigan Natural Resources and Environmental Protection Act, 1994 PA 451, as amended, MCL 324.101 et seq. signed November 1, 2010 (Order) obligates Enbridge Energy, Limited Partnership (Enbridge) to perform response and restoration activities at and near the location of the release of crude oil in Marshall, Michigan. This document presents the *Sampling and Analysis Plan (SAP)* that will be used to define sampling and analyses for Enbridge's continued evaluation, characterization, remediation, and restoration of the Spill, as required under Paragraph 7.1(b) of the Order. Work plans will be developed for activities completed under the Order. These work plans will describe activities that will be performed following the procedures in this SAP, following the quality assurance and quality control procedures defined in the *Quality Assurance Project Plan (QAPP)* submitted on August 19, 2011 (Enbridge, 2011), and following the safety procedures in the site specific *Health and Safety Plan (HASP)* submitted on November 11, 2010 (Enbridge, 2010a).

On July 26, 2010, Enbridge discovered a release of crude oil from Line 6B, a 30-inch diameter line, just west of mile post (MP) 608 in the vicinity of its pump station located in Marshall, Calhoun County, Michigan (N1/2, Section 2, T3S, R6W Latitude: 42.2395273 Longitude: -84.9662018). Approximately 840,000 gallons of crude oil were released and entered Talmadge Creek and subsequently the Kalamazoo River at a time when the river was above flood stage. As a result, oil migrated down Talmadge Creek and the Kalamazoo River and impacted flood plain areas including the shoreline, bank area, and some overbank areas, upstream of the Morrow Lake Dam. In addition, submerged oil settled in portions of the river bottom upstream from the Morrow Lake Dam. Enbridge immediately initiated response activities to remove the crude oil.

Response activities under the direction of the United States Environmental Protection Agency (U.S. EPA) completed and/or on-going since the release include, but are not limited to:

- Shut-down of pipeline and closing of isolation valves,
- Installation and operations of flumes (underflow weirs) down gradient of the release area,

- Installation and operation of oil and water containment and recovery systems,
- Development of a system of MP markers to label all divisions of the river for study,
- Development and implementation of plans for response activities for the source area (*Source Area Response Plan* (Enbridge, 2010c)) and of downstream impacts (*Response Plan for Downstream Impacted Area* (Enbridge, 2010d)),
- Preparation of a SAP dated August 17, 2010 and QAPP for work directed by the U.S. EPA,
- Sediment and surface water monitoring,
- Residential well sampling and monitoring,
- Source Area Response activities that included excavation of impacted soils as documented in the *Source Contamination Removal and Verification Summary Report* (Enbridge, 2010b),
- Downstream excavation of impacted soil,
- Air monitoring and sampling,
- Shoreline Assessment Technique (SCAT) process, and
- Characterization and remediation activities for submerged oil.

Shortly after the release at Line 6B, Enbridge developed a SAP that was approved by the U.S. EPA and defined sampling activities performed for the U.S. EPA (Enbridge Line 6B MP 608 Pipeline Release Marshall, Michigan *Sampling and Analysis Plan*; final dated August 17, 2010 referred to here as the U.S. EPA SAP). The U.S. EPA SAP was used during the response activities directed by the U.S. EPA. For activities being completed under the U.S. EPA directed activities, the U.S. EPA SAP will continue to be the controlling SAP, while for activities being directed by the MDEQ, this document is the controlling SAP. Some activities will be transitioned from oversight by the U.S. EPA to oversight by the MDEQ and will therefore transition from the U.S. EPA SAP for U.S. EPA directed activities to this SAP for MDEQ directed activities. Examples of activities that will transition to MDEQ oversight are the monitoring of the surface water and sediments and monitoring of residential potable wells.

1.1 Overview of Field Activities

This SAP covers sampling and analysis of environmental media to comply with the Order. Field activities include sampling and analysis of groundwater, surface water, drinking water, soil, and sediment. Section 7 of the Order defines the work to be performed in a broad sense, and a variety of field methods will be required. To complete this work, numerous types of sampling and investigation methods will be required. Sampling and investigation procedures are addressed by the Standard Operating Procedures (SOPs) included as *Attachment A*. It is expected that new SOPs will be required to perform sampling activities described in work plans under the Order. As new sampling methods are proposed, new SOPs will be developed, forwarded to MDEQ for approval and then added to *Attachment A* as an addendum to this SAP. In addition, if site conditions or investigation objectives require modifications to the existing SOPs, those modifications will also be developed and submitted to the MDEQ (as required) as amendments to this SAP. Any deviation from these SOPs will be documented in field records and be included in associated final submitted reports.

Ongoing monitoring activities performed under the original U.S. EPA SAP are now addressed under this SAP. These monitoring activities include the monitoring of residential drinking water wells within 200 feet of the high water mark during the release (*Attachment B*) and the surface water and sediment monitoring (*Attachment C*). Ongoing groundwater monitoring activities will also be performed as outlined in work plans as they are developed.

1.2 Project Organization

Enbridge has developed a project team with the appropriate skills to complete the work required under the Order. The project organization and the responsibilities of key personnel are defined in the QAPP.

2.0 OVERVIEW OF SAMPLING ACTIVITIES

The environmental media to be sampled will be defined in each work plan. At a minimum, this SAP is designed to address sampling of groundwater, surface water, drinking water, soil, and sediment. Quality assurance and quality control procedures and all analytical procedures are described in the QAPP. The data obtained from all sampling, along with any significant field observations from collection locations (e.g. presence of sheen, etc.) will be summarized and provided daily to the Task Manager. Data and observations will reviewed by the Task Manager to determine if the level of effort is appropriate.

2.1 Field Standard Operating Procedures

The consistent collection of samples and information in the field that will support the project objectives will be accomplished through the development and implementation of SOPs for work tasks being performed. The SOPs for this project are included in *Attachment A*.

2.2 Data Quality Objectives

The data quality objectives (DQOs) are required to assure that the data collected under the SAP will adequately support the decisions and evaluations required to meet the objectives of the sampling. Sampling activities that will be required under the Order are defined in Section 7.5 which defines the requirements that may lead to sampling:

- *"Define the nature and extent of contamination,*
- *Evaluate all exposure pathways,*
- *Evaluate the ecological and aesthetic impacts from the spill and the initial response activities,*
- *Identify and implement additional response activities necessary to achieve compliance with applicable state criteria, and*
- *Address impacts of the oil spill and response and restoration activities on all media, including but not limited to soil, surface water, wetlands and floodplains, groundwater, sediment, fish, benthic invertebrates, and wildlife."*

The requirements for monitoring will also be performed under this SAP; Section 7.7 of the Order provides the following requirements for monitoring:

> *"Evaluate the short- and long-term impact of the oil spill, response activities, and restoration activities on all affected natural resources and environmental media to determine progress toward compliance with NREPA and other applicable law."*

DQOs are both qualitative and quantitative statements that clarify objectives, define the appropriate type of data and specify the tolerance level prescribed for each action. The U.S. EPA document *"Guidance on Systematic Planning Using the Data Quality Objectives Process (EPA QA/G-4)"* (U.S. EPA, 2006) identifies the following seven step sample planning approach, detailed below, which will be used for this project.

1. State the Problem
2. Identify the Goal of the Study
3. Identify Information Inputs
4. Define the Boundaries of the Study
5. Develop the Analytic Approach
6. Specify Performance or Acceptance Criteria
7. Develop the Plan for Obtaining Data

This approach is iterative in nature due to the size, complexity, and simultaneous activities which will be required to be completed on this project. As resolutions to key data gaps are developed, they will be used (as appropriate) to develop DQOs for subsequent portions of the project.

The MDEQ has developed guidance that supports the implementation of investigation activities in the State of Michigan to assure that data is of sufficient quality to support review by the MDEQ. This SAP and the associated QAPP are built upon the foundations of the MDEQ Operational Memorandum, including *Remediation and Redevelopment (RRD) Operational Memorandum No. 2. Sampling and Analysis (MDEQ, 2004)*. Achieving the data objectives contained in RRD Operational Memorandum No. 2 shall be used to direct achieving the data quality objectives for this study.

3.0 SAMPLE MANAGEMENT

A sample management program has been developed to manage sample integrity from collection through delivery to the laboratory. The sample management program includes: sample labeling, documentation of field observations and sample information, and chain of custody procedures.

3.1 Sample Labeling

Labeling of samples collected under this work plan will use a standardized sample nomenclature designed for this project. This nomenclature is built to support sampling for this project throughout a study area stretching along two miles of Talmadge Creek and 37 miles of the Kalamazoo River. This project also includes areas that are not proximal to either surface water body, such as the source areas and support facilities. The sample nomenclature provides unique names for each sample location and also for each sample collected from a sample location.

3.1.1 Location Identification

A location is defined as a location on the ground or water surface where a sample will be collected. A unique label will be assigned to each location where a sample will be collected. Many samples may be drawn from a single location for instance; multiple samples may be collected from

- a single monitoring well,
- a fixed location on a surface water body, and
- different depths at a single soil boring.

The nomenclature for each location is defined in *Table 1*.

3.1.2 Sample Identification

A sample is defined as a discrete sample of an environmental media or blank. Samples of environmental media will be associated with the location where the sample is collected. The nomenclature for each sample collected is defined in *Table 2*.

3.2 Documentation of Field Observations and Sample Information

Observations and measurements made in the field will be captured, stored, and utilized to achieve the objectives of the Order. Field documentation will be captured utilizing one or more of three methods: (1) digital capture, (2) customized field forms, or (3) entry into a field notebook. When performed correctly, all three methods can provide data of the quality necessary to meet the objectives of the work performed under the Order.

Digital capture of field observations and measurements will be performed on programmed hand-held field computers such as Trimble Yumas®. These units will use customized field forms for data entry, enforce valid values on certain entry fields, directly capture survey coordinates, and automatically link photographs to field forms. Use of digital capture devices can increase the quality of data by requiring mandatory fields, limiting entries to valid values, and eliminating typographical errors during later data entry from paper forms.

Field forms may be used for standardized field tasks when the information necessary in the field is pre-defined. Examples of pre-printed forms used in the field include water level measurement forms and chain of custody (COC) forms. If possible, sample locations and other information will be pre-printed on the forms to assure completeness of the field activity and also to minimize the opportunity for errors entering location information on the forms.

Field log books will be utilized to capture information that is not suited for entry in a field computer or entry onto a form. In addition, field log books will also be used if the space on the field forms is filled, or if the digital capture devices fail to operate in the field.

Sample labels will be prepared which include the sample name, date and time of sampling, requested analyses, and preservatives used. A COC will also be prepared in the field by the sampling team. Samples will be packaged and shipped by overnight courier in a sealed cooler packed with ice following SOP EN-103 - *Packaging and Shipment of Environmental Samples* located in *Attachment A*.

3.2.1 Field Log Books

All field activities will be carefully documented in field log books and/or on field forms. Entries will be of sufficient detail and will give a complete daily record of significant events, observations, and measurements. The field log book will provide a legal record of the activities conducted in the field and will comply with guidelines outlined in *SOP EN-101 - Field Records* which is located in *Attachment A*.

3.3 Chain of Custody Procedures

Chain of custody (COC) Procedures are described in the attached *SOP EN-102 - Chain of Custody Procedures* included in *Attachment A*.

4.0 DECONTAMINATION PROCEDURES

The process for decontamination of field equipment used in the collection of environmental samples associated with the project is addressed in the attached *SOP EN-105 - Decontamination of Field Equipment* included in *Attachment A*. Field equipment for decontamination may include a variety of items used in the field for monitoring and/or for collection of soil, sediment, and/or water samples, such as water level meters, water quality monitoring meters (turbidity meter, multi-parameter meter), split-spoon samplers, trowels, scoops, spoons, and pumps. Heavy equipment such as drill rigs also require decontamination, usually in specially constructed temporary decontamination areas.

Decontamination is performed as a quality assurance measure and a safety precaution. Improperly decontaminated sampling equipment can lead to misinterpretation of environmental data due to interference caused by cross-contamination between samples or sample locations through use of contaminated equipment. Decontamination also protects field personnel from potential exposure to hazardous materials on equipment.

5.0 INVESTIGATIVE DERIVED WASTE MANAGEMENT

Investigative derived waste (IDW) will be managed appropriately in accordance with the attached *SOP EN-106 - Investigative Derived Waste Management* (*Attachment A*). IDW will be collected, labeled, stored, and disposed of appropriately during sampling and investigative activities except under limited situations where the material is known to not be impacted. Composite waste characterization samples of solid waste will be collected on an as-needed basis as activities and accumulated quantities dictate. Results of the waste characterization sampling will dictate which licensed landfill the material will be transported to for disposal.

In limited situations, certain materials derived from sampling are known not to be a waste requiring collection and storage. These situations include the management of water purged during sampling of a residential well and the management of water purged during sampling of a monitoring well that has previous analytical samples documenting that the groundwater is not impacted. In these situations, the un-impacted purge water will be discharged onto the ground away from the well casing.

6.0 REFERENCES

Enbridge, 2010a. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Health and Safety Plan (HASP). August 2010.

Enbridge, 2011. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Quality Assurance Project Plan (QAPP). August 19, 2010.

Enbridge, 2010b. Source Contamination Removal and Verification Summary Report, September 21, 2010.

Enbridge, 2010c. Source Area Response Plan, August 2, 2010.

Enbridge, 2010d. Response Plan for Downstream Impacted Areas, August 2, 2010.

MDNR, 2004. RRD Operational Memorandum No. 2; Sampling and Analysis. October, 22, 2004. http://www.michigan.gov/deq/0,1607,7-135-3311_4109_9846-101581--,00.html

U.S. EPA, 2006. Guidance on Systematic Planning Using the Data Quality Objectives Process (EPA QA/G-4). EPA/240/B-06/001 (http://www.epa.gov/quality/qs-docs/g4-final.pdf).

Administrative Consent Order and Partial Settlement Agreement entered *In the Matter of Enbridge Energy Partners, L.P., and Enbridge Energy, Limited Partnership,* proceedings under the Michigan Natural Resources and Environmental Protection Act, 1994 PA 451, as amended, MCL 324.101 et seq. signed November 1, 2010 (Order)

U.S. EPA SAP, Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Sampling and Analysis Plan. August 17, 2010.

Tables

Table 1. Location Nomenclature

Location and Sample nomenclature for the MDEQ Order
The Location identifies the location on the ground where a sample is collected.
The Sample provides a unique identification of each sample collected.

Location Identification - Near a Surface Water
2 digit type & 2 digit area & 4 digit mile post & 1 letter bank & 2 digit integer

Type								Area				MP	Bank ID			Integer
MW	SE	SB	SW	SS	PW	SG	TG	TC	TU	KR	KU		L	R	C	
Monitoring Well	Sediment	Soil Boring	Surface Water	Surface Soil	Pore Water	Staff Gauge	TarGOST®	Talmadge Creek	Talmadge Upstream	Kalamazoo River	Kalamazoo Upstream	4 digits	Left	Right	In Channel	2 digits

TC	Talmadge Creek where MPs exist
TU	Talmadge Creek upstream from 0.00 (miles upstream from 0.00)
KR	Kalamazoo River downstream from confluence of TC
KU	Kalamazoo River upstream of confluence of TC (miles up river)
MP	Mile post designation times 100: MP 34.25 translates to 3425

Examples:

MWKR3025L01	monitor well 1 on left descending bank of the Kalamazoo River near MP 30.25
SBTC0050R04	soil boring 4 on right descending bank of Talmadge Creek near MP 00.50
SBKU0125R02	soil boring 2 on right descending bank of the Kalamazoo River 1.25 miles upstream of the confluence with Talmadge Creek

Table 1. Location Nomenclature

Location Identification - Away from a Surface Water

Source Area

Two digit type & two digit area & four digit integer

Type							Area	Integer
MW	SE	SB	SW	SS	PW	TG	SA	
Monitoring Well	Sediment	Soil Boring	Surface Water	Surface Soil	Pore Water	TarGOST®	Source Area	4 digits

Examples:

MWSA0023 monitoring well 23 in the source area

SBSA0127 soil boring 127 in the source area

TGSA0002 TarGOST® location 2 in the source area

Staging Yard and Frac Tank City

Two digit type & two digit area & four digit integer

Type						Area	Integer	
MW	SE	SB	SW	SS	WW	SY		
Monitoring Well	Sediment	Soil Boring	Surface Water	Surface Soil	Waste Water	Staging Yard	2 digit yard ID &	2 digit integer

Type						Area	Integer
MW	SE	SB	SW	SS	WW	FT	
Monitoring Well	Sediment	Soil Boring	Surface Water	Surface Soil	Waste Water	Frac Tank City	4 digits

Type						Type	Site	Integer
MW	SE	SB	SW	SS	WW	RA	X999	
Monitoring Well	Sediment	Soil Boring	Surface Water	Surface Soil	Waste Water	River Access Sites	1 letter & 3 digits to designate site (i.e. D250)	4 digits

Table 1. Location Nomenclature

Examples:

SBFT0002	soil boring 2 associated with Frac Tank City
SSSY0305	surface sample 05 from staging yard 3

NOTE: Cluster wells each get individual location names.

Table 2. Sample Nomenclature

Sample Identification Nomenclature

Add the following after the Location ID information to identify the sample.
1 digit type & 6 digit date & 1 digit matrix & 3 digit integer depth or X for none

Type (1 digit)				Date (6 digits)			Matrix (1 digit)							Depth	
S	D	E	T	Mo	D	Yr	A	D	F	G	S	W	M		X
Regular Sample	Duplicate	Equipment Blank	Trip Blank	Month	Day	Year	Air	Sediment	Surface Water	Groundwater	Soil	water (blank)	methanol (blank)	3 Digits	No Depth

Depth below grade (feet) to top of sample times 10 as 3 digits: 2.5 feet is 025.
For samples with no depth (groundwater, surface water) use X

Example of string added to the Location ID:
S101710GX Groundwater sample collected 10/17/10 - depth not specified
S102110S025 Soil sample collected 10/21/10 with a top depth of 2.5 ft

**Note "-split" will be added to the Sample ID when the agency splits a sample

Full example
MWKR3025L01S101710GX

Groundwater sample collected 10/17/10 from monitor well 1 on left descending bank of the Kalamazoo River at MP 30.25

SBTC0050R04S102110S025

Soil sample collected from a depth of 2.5 ft on 10/21/10 from soil boring 4 on right descending bank of Talmadge Creek at MP 00.50

Talmadge Creek Oil Study Soil Core Nomenclature

TC	FB	9999	+	99	X	99
Two Character - Talmadge Creek	Two Character - February	Four Digit Station	Plus	Two Digit Station	Bank or In Channel: L, R, or C	Sequence Two Digits

Examples

TCFB0001+50L01
TCFB1050+00R26
TCFB0250+50C02

Bank is descending bank - looking downstream

TarGOST® along the Talmadge Creek

TG	TC	9999	+	99	X	99
TarGOST®	Two Character - Talmadge Creek	Four Digit Station	Plus	Two Digit Station	Bank or In Channel: L, R, or C	Sequence Two Digits

Attachment A

Standard Operating Procedures

SOP Document Log				
Current SOP #	**Old SOP #**	**Title**	**Revison**	**Date**
SOP EN-101	SOP EN-007	**Field Records**	0	08/22/11
SOP EN-102	SOP EN-013	**Chain of Custody Procedures**	1	08/22/11
SOP EN-103	SOP EN-014	**Packaging and Shipment of Environmental Samples**	1	08/22/11
SOP EN-104	SOP EN-020	**Survey**	0	08/22/11
SOP EN-105	SOP EN-022	**Decontamination of Field Equipment**	1	08/22/11
SOP EN-106	SOP EN-030	**Investigative Derived Waste Management**	1	08/22/11
SOP EN-201	SOP EN-012	**Surface Water Sample Collection**	1	08/22/11
SOP EN-202	SOP EN-015	**Sediment Sample Collection**	0	08/22/11
SOP EN-203	none	**Procedures for Thin Sheen Oil Sample Collection**	n/a	08/22/11
SOP EN-204	none	**Static Sheen Testing**	n/a	08/22/11
SOP EN-301	SOP EN-001	**Subsurface Soil Sampling by Geoprobe™ Methods**	1	08/22/11
SOP EN-302	SOP EN-002	**Subsurface Soil Sampling by Hollow Stem Auger and Split-Spoon Sampler Methods**	1	08/22/11
SOP EN-303	SOP EN-003	**Subsurface Soil Sampling by Sonic Drilling Methods**	1	08/22/11
SOP EN-304	SOP EN-004	**Surface Soil Sampling**	1	08/22/11
SOP EN-305	none	**Soil Sampling Via hand Auger**	n/a	08/22/11
SOP EN-306	none	**Bedrock Coring With Sonic Drilling Methods**	n/a	08/22/11
SOP EN-401	SOP EN-005	**Monitoring Well Construction and Installation**	1	08/22/11
SOP EN-402	SOP EN-006	**Monitoring Well Development**	1	08/22/11
SOP EN-403	SOP EN-008	**Water Level Measurement in a Monitoring Well**	1	08/22/11
SOP EN-404	SOP EN-010	**Low Flow Groundwater Sampling**	1	08/22/11
SOP EN-405	SOP EN-011	**Sample Collection from Drinking Water Wells**	1	08/22/11
SOP EN-406	none	**Groundwater Sampling via Temporary Wells**	n/a	08/22/11
SOP EN-501	SOP EN-009	**Headspace Analysis in Unsaturated Soil Samples**	1	08/22/11
SOP EN-502	none	**Water Quality Instrumentation**	n/a	08/22/11
SOP EN-503	none	**Photoionization Detector Measurement**	n/a	08/22/11

Approved

Enbridge Line 6B MP 608

Marshall, MI Pipeline Release

Field Records– SOP EN-101

Prepared for Michigan Department of Environmental Quality

Enbridge Energy, Limited Partnership

Submitted: November 11, 2010

Approved: August 30, 2011

Approved

ATTACHMENTS

Approved

LIST OF ACRONYMS

Enbridge	Enbridge Energy, Limited Partnership
GPS	Global Positioning System
HASP	Health and Safety Plan
NCR	Nonconformance Report
MS/MSD	Matrix Spike / Matrix Spike Duplicate
NCR	nonconformance report
OSHA	Occupations Safety and Health Administration
PDA	Personal Digital Assistant
Project	Enbridge Line 6B MP 608 Marshall, Michigan Pipeline Release
QAPP	Quality Assurance Project Plan
QC	Quality Control
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedure

1.0 SCOPE AND METHOD SUMMARY

This Standard Operating Procedure (SOP) provides guidance for documentation of field activities associated with Enbridge Line 6B MP 608 Marshall, Michigan Pipeline Release (Project) operations, including, but not limited to; sample collection, field measurements, and groundwater monitoring well installation. Appropriate documentation of field activities provides an accurate and comprehensive record of the work performed, sufficient for a technical peer to reconstruct the day's activities and determine that necessary requirements were met. Field records also provide evidence and support technical interpretations and judgments. The procedures and systems defined in this SOP help ensure that the records are identifiable (reference the project task/activity), legible, retrievable, and protected from loss or damage.

Project field data may be recorded electronically or in field logbooks, standardized forms, annotated maps, or photos. This SOP provides general guidance on field recordkeeping; additional details for specific procedures (for example, chain of custody, sample collection) are provided in the SOPs for the individual task.

It is expected that the procedures outlined in this SOP will be followed. Procedural modifications may be warranted depending on field conditions, equipment limitations, or limitations imposed by the procedure. Substantive modification to this SOP will be noted in task-specific work plans or on Field Modification Forms and will be approved in advance by the Task Manager. Deviations from the SOP will be documented in the project records and in subsequent reports

2.0 PERSONNEL QUALIFICATIONS

It is the responsibility of the field personnel to be familiar with the procedures outlined in this SOP. It is also the responsibility of the field personnel to be familiar with the procedures outlined within this *Sampling and Analysis Plan (SAP)* (Enbridge, 2011a), the *Quality Assurance Project Plan (QAPP)* (Enbridge, 2011b), and the *Health and Safety Plan* (HASP) (Enbridge, 2010).

Personnel who work on sites where hazardous waste materials may be present will be health and safety certified as specified by the *Occupational Safety and Health Administration (OSHA) (29CFR 1910.120(e)(3)(i)).*

3.0 HEALTH AND SAFETY

The health and safety considerations for the work associated with this SOP, including both potential physical and chemical hazards, is addressed in the site specific HASP. All work will be conducted in accordance with the HASP.

4.0 INTERFERENCES

Not Applicable.

5.0 EQUIPMENT AND SUPPLIES

The following equipment list contains materials which may be needed in carrying out the procedures contained in this SOP. Not all equipment listed below may be necessary for a specific activity. Additional equipment may be required, pending field conditions.

- Bound field logbook (preferably waterproof, such as Rite-in-Rain™),
- Standardized field data sheets,
- Black or blue, ballpoint pen with indelible ink,
- Sharpie® (or equivalent permanent marker),
- Site maps,
- Clipboard,
- Three-ring binder or equivalent,
- Camera (optional),
- Time piece,
- Hand-held electronic recording device (such as Trimble Yuma®) (optional), and
- Laptop computer or tablet PC (optional).

6.0 METHODS

6.1 General Requirements

- The field records will contain sufficient detail so that the collection effort can be reconstructed without reliance on the collector's memory.
- Pertinent field information will be recorded legibly in a logbook and/or an appropriate standardized form (as described herein). Entries should be made with a ballpoint pen with black or blue indelible ink or a permanent marker. Pencils should not be used. If a ballpoint pen or permanent marker cannot be used because of adverse weather conditions (rain or freezing temperatures) and only a pencil can be used, an explanation must be included in the logbook and the affected data should be photocopied, signed as verified copy, and maintained in the project files as documentation that the data has not been changed.
- Entries will be signed and dated. No erasures or obliterations will be made. A single line strikeout will be drawn through incorrect entries and the corrected entry written next to the original strikeout. Strikeouts are to be initialed and dated by the originator.
- Entries will be factual and observational (i.e., no speculation or opinion), and will not contain any personal information or non-project-related entries. Abbreviations and acronyms will be defined.
- Field information will be recorded without delay – information recorded significantly after the fact will be dated as such.
- Field activities and other events pertinent to the field activities will be documented in chronological order. Times will be recorded using military time or Eastern Time.

6.2 Field Logbooks

The cover and binding of each logbook will be labeled to identify the operation and dates included with the logbook; each page in the logbook will be consecutively numbered. Pages will not be removed or torn out of the logbook.

The title page of each logbook will contain the following:

- AECOM contact, AECOM office location, and phone number;
- The logbook number (assigned at the time the logbook is signed out);

- Project name and AECOM project number; and
- Start and end dates of work covered by the logbook.

At the front of each logbook will be a page cross-referencing each author's printed name, signature, and initials.

A page header will appear on the first page of each day's notes in the logbook, and activities for each day will be recorded on a new page. The page header will include:

- Name of author and other personnel on site (and affiliated organization if applicable);
- Date;
- Time of arrival;
- Proposed activity (task); and
- Current weather and weather forecast for the day.

An abbreviated header, containing at least the date, authors name, and project number, will appear at the top of each additional page for the active date. Field forms require similar header information.

The field logbook will provide a chronology of events. At a minimum, documentation in a logbook will include the following (unless documented on a standard form):

- Names of visitor(s), including time of arrival and departure, the visitor's affiliation, and reason for visit;
- Summary of project-related communications, including names of people involved and time;
- Time daily work commences and ceases;
- Start and stop times of new tasks;
- Start and stop times of significant stand-by time (work interruptions);
- Safety or other monitoring data, including units with each measurement;
- Deviations from approved scope of work, including the necessary approvals;
- Progress updates;
- Problems/delays encountered;
- Unusual events; and
- Signature or initials of author on every page.

The logbook will cross-reference the field forms if necessary; however, whenever possible, details recorded on the standardized forms will not be replicated in the logbook.

If there are additional lines on the page at the end of the day's activities, a line will be drawn through the empty space, and initialed and dated, leaving no room for additional entries.

6.3 Standardized Forms

Standard forms for field data are provided in the electronic project files.

The information collected on any field form may alternately be collected electronically by a laptop computer or electronic handheld device as appropriate.

The following rules apply to the standardized forms:

- Each form will be signed and dated by the person completing the form.
- There will be no blank spaces on the form – unused spaces will have "not applicable" or "not available" explanations.

6.4 Maps and Drawings

Pre-existing maps and drawings that include notations made in the field (for example, relocating of sample locations) will be referenced in the logbook and, like all field records, include the project/task name and number, site identification, and be signed/dated by the person that prepared them.

Maps and drawings will include compass orientation and scale. Sketches will include points of reference and distances to the reference points.

6.5 Photo Documentation

Photographs or videos may be taken by the field team to help document site conditions, sample locations, or sample characteristics. Photographs and videos will be identified in the logbook or on the standard form by a unique numbering system. If photographs are collected by a digital camera, the file number as well as the photograph number will accompany the description of the photograph in the logbook. At a minimum, the date/time the photograph was taken, the general location, a brief description, and the photographer's name will be recorded. Additional information may include Global Positioning System (GPS) coordinates, direction the photographer was facing, and/or weather conditions. If necessary, an object will be included to indicate the scale of the object in the photograph.

6.6 Electronic Files

Electronically recording devices may include data logging systems, personal digital assistants (PDAs), laptops, tablet PCs, etc.

Sufficient backup systems will be in place to protect against electronic data loss. Information will be saved to a disk or backed up at the end of each day. The backup disk or other media (CD, flash drive) will then be stored in a secure location separate from the laptop, tablet, PDA, etc.

Files will be uniquely identified and will be stored in the project files on the network. An unedited version of the file will be maintained and all subsequent manipulations tracked.

7.0 DATA AND RECORDS MANAGEMENT

Deviations to the procedures detailed in the SOP or approved plans will be noted in the field logbook or other appropriate field form at the time of occurrence. A formal nonconformance report *(*NCR*)* will be completed and distributed to the Field Team Leader, Task Leader and Project Manager. An example NCR is presented as *Attachment 1*.

Proposed modifications to the SOPs or approved plans will be documented on a Field Modification Form and submitted to the Task Manager. An example Field Modification Form is presented as *Attachment 2*.

Logbooks that are taken offsite from the field facility will be photocopied or scanned and filed at the end of each day to mitigate against the loss of historical entries should the logbook be lost in the field.

Field data forms and chain of custody will be filed in the field facility once they have been completed and distributed (if necessary), or at the end of each field day. These documents will be maintained in labeled three-ring binders or contained in some other organized manner that prevents loss.

Distribution of daily forms will be performed according to the needs of the project team and at the direction of the Field Task Manager or designee.

8.0 QUALITY ASSURANCE AND QUALITY CONTROL

Quality Control (QC) samples collected may include field duplicates, equipment and/or field blanks, trip blanks, and matrix spike/matrix spike duplicates (MS/MSD). See the QAPP for collection frequency and methods.

Approved

9.0 REFERENCES

Enbridge, 2011a. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Sampling and Analysis Plan (SAP). August 30, 2011.

Enbridge, 2011b. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Quality Assurance Project Plan (QAPP). August 19, 2011.

Enbridge, 2010. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Health and Safety Plan (HASP). August 2010.

Attachments

Attachment 1	**Nonconformance Form**
Attachment 2	**Field Modification Form**

Attachment 1

NonConformance Form
Enbridge, Marshall, MI

Nonconformance Number:	
Document (plan or SOP title and date)	
Activity:	
Nonconformance:	
Date of Nonconformance:	
Ramifications/Corrective Action:	
Submitted By:	**Date:**
Field Mgr. Approval:	**Date:**
Task Mgr. Approval:	**Date:**
QA Mgr. Approval:	**Date:**

Attachment 2

Field Modification Form

Enbridge, Marshall, MI

Field Modification Number:	
Document (plan or SOP title and date)	
Activity:	
Proposed Modification:	
Effective Date(s):	
Rationale:	
Submitted By:	**Date:**
Field Mgr. Approval:	**Date:**
Task Mgr. Approval:	**Date:**
QA Mgr. Notification:	**Date:**

Approved

Enbridge Line 6B MP 608

Marshall, MI Pipeline Release

Chain of Custody Procedures– SOP EN-102

Prepared for Michigan Department of Environmental Quality

Enbridge Energy, Limited Partnership

Submitted: November 11, 2010

Approved: August 30, 2011

Approved

LIST OF ACRONYMS

COC	chain of custody
Enbridge	Enbridge Energy, Limited Partnership
HASP	Health and Safety Plan
MDEQ	Michigan Department of Environmental Quality
Order	Administrative Consent Order And Partial Settlement Agreement entered *In the Matter of Enbridge Energy Partners, L.P., and Enbridge Energy, Limited Partnership*, proceedings under the Michigan Natural Resources and Environmental Protection Act, 1994 PA 451, as amended, MCL 324.101 et seq. signed November 1, 2010
MDNR	Michigan Department of Natural Resources
MP	mile post
QC	Quality Control
OSHA	Occupations Safety and Health Administration
QAPP	Quality Assurance Project Plan
SOP	Standard Operating Procedure
U.S. EPA	United States Environmental Protection Agency

1.0 SCOPE & METHOD SUMMARY

This Standard Operating Procedure (SOP) describes the methods to be used for completing the chain of custody (COC) used in the collection of environmental samples. The National Enforcement Investigations Center of the United States Environmental Protection Agency (U.S. EPA) defines custody of evidence in the following manner:

- It is in your actual possession;
- It is in your view, after being in your physical possession;
- It was in your possession and then you locked or sealed it up to prevent tampering; or
- It is in a secure area.

2.0 PERSONNEL QUALIFICATIONS

Individuals responsible for completing COC documentation must be personnel working on the specific field program, have read this SOP, and have worked under the oversight of experienced personnel. For certain sampling programs, the Project Manager, Task Manager, or designee may assign an individual to serve as sample custodian. This individual is responsible for supervising the implementation of COC procedures in accordance with this SOP and any project-specific work plans or *Quality Assurance Project Plan* (QAPP)(Enbridge, 2011).

Personnel who will work on sites where hazardous waste materials may be present will be health and safety certified as specified by the *Occupational Safety and Health Administration* (OSHA) *(29 CFR 1910.120(e)(3)(i).*

3.0 HEALTH AND SAFETY

The health and safety considerations for the work associated with this SOP, including both potential physical and chemical hazards, is addressed in the site specific *Health and Safety Plan (*HASP*)* (Enbridge, 2010). All work will be conducted in accordance with the HASP*.*

4.0 INTERFERENCES

Not Applicable.

5.0 EQUIPMENT & SUPPLIES

The following equipment list contains materials which may be needed in carrying out the procedures contained in this SOP. Not all equipment listed below may be necessary for a specific activity. Additional equipment may be required, pending field conditions.

- Sample Labels,
- COC Form,
- Field Project Logbook,
- COC Tape or Custody Seals, and
- Pen with indelible ink and/or permanent marker.

6.0 METHOD

6.1 Sample Labeling

Labeling of samples occurs at the time of sample collection. Waterproof, adhesive labels are preferred. Labels should be applied to the container, not the lid whenever possible. Additional interior labels may be required for certain biological samples.

Labels should be completed in indelible ink. Covering the label with clear plastic tape is recommended to protect the legibility of the label and to prevent the label from detaching from the sample container.

The following information should be recorded on the sample label:

- Project Identification (project name and number/client/site),
- Field Sample Identification Number (exactly as it appears on the COC form),
- Sampler's Initials,
- Date and Time of Sample Collection,
- Analyses Requested, and
- Preservation.

6.2 Field Custody

The field personnel are required to complete the following information on the COC form:

- Project Number,
- Client or Project Name,
- Project Location,
- Page number (e.g., 1 of 2, 2 of 2, etc.),
- Laboratory name and address,
- Field Sample Identification Number,
- Date and Time of Sample Collection,
- Sample Matrix,
- Preservative,
- Analysis Requested,
- Sampler's Signature,

- Signature of Person Relinquishing Sample Custody,
- Date and Time Relinquished,
- Sampler Remarks,
- Air Bill number (if shipped by an overnight commercial carrier), and
- COC Tape or Custody Seal Number(s).

Hand-written COCs must be filled out completely and legibly in indelible ink. Corrections will be made, if necessary, by drawing a single line strikethrough and initialing and dating the error. The correct information is then recorded with indelible ink. If a correction is needed on a computer generated COC form, it must be corrected in the program from which it was created and reprinted. It cannot be corrected with a single line method. All transfers from field personnel to laboratory personnel are recorded on the COC form in the "Relinquished By" and "Received By" sections.

If samples are to be shipped by overnight commercial courier (e.g., Federal Express), the field personnel must complete a COC form for each package (e.g., cooler) of samples and place a copy of each completed form inside the associated package before the package is sealed. Each completed COC form must accurately list the sample identification numbers of the samples with which it is packaged. Alternately, a copy of the original COC form may be placed in each package. The copy of the COC form must at a minimum list the samples that are contained in the respective package. The original COC from must be included in one of the packages. It is not necessary for the shipping company to sign the COC. Sample packaging will be conducted in accordance with *SOP EN-103 – Packaging and Shipment of Environmental Samples.*

If samples are hand carried to a laboratory, the person hand carrying the samples is the sample custodian. If the carrier is a different person than the one who filled out the COC form and packaged the samples, then that person must transfer custody to the carrier by signing and dating each form in the "Relinquished By" section. The carrier must then sign and date each form in the adjacent "Received By" section. When the carrier transfers the samples to the laboratory, he or she must sign and date each form in the next "Relinquished By" section, and the laboratory sample custodian must sign and date each form in the adjacent "Received By" section.

6.3 Laboratory Sample Receipt and Inspection

Upon sample receipt, the coolers or packages are inspected for general condition and the condition of the COC tape or custody seal. The coolers or boxes are then opened and each sample is inspected for damage.

Sample containers are removed from packing material and sample label field identification numbers are verified against the COC form.

The following information is recorded in the laboratory's records:

- Air Bill number (if appropriate),
- Presence/absence of COC forms,
- Condition of samples,
- Discrepancies noted,
- Holding time and preservatives, and
- Sample storage location.

The COC form is completed by signing and recording the date and time of receipt.

The Task Manager or designee must be notified of any breakage, temperature exceedance, or discrepancies between the COC paperwork and the samples.

Approved

7.0 DATA & RECORDS MANAGEMENT

The data associated with COC procedures is contained within the following:

- Sample labels,
- Chain of custody records and custody seal(s), and
- Sample collection records.

The following SOPs describe the data collection and record management procedures that should be followed as part of the COC procedure:

- *SOP EN-101 Field Records,* and
- *SOP EN-103 Packaging and Shipment of Environmental Samples.*

Approved

8.0 QUALITY CONTROL & QUALITY ASSURANCE

The records generated in this procedure are subject to review during data validation, in accordance with the QAPP.

Quality Control (QC) samples collected may include field duplicates, equipment and/or field blanks, trip blanks, and matrix spike/matrix spike duplicates (MS/MSD). See the QAPP for collection frequency and methods.

9.0 REFERENCES

Enbridge, 2010. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Health and Safety Plan (HASP). August 2010.

Enbridge, 2011. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Quality Assurance Project Plan (QAPP). August 19, 2011.

SOP EN-101 – Field Records

SOP EN-103 - Packaging and Shipment of Environmental Samples.

American Society for Testing and Materials (ASTM). 2004. Standard Guide for Sample Chain of Custody Procedures. D 4840-99 (Reapproved 2004).

Approved

Enbridge Line 6B MP 608

Marshall, MI Pipeline Release

Packaging and Shipping – SOP EN-103

Prepared for Michigan Department of Environmental Quality

Enbridge Energy, Limited Partnership

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LIST OF ACRONYMS

HASP	Health and Safety Plan
OSHA	Occupations Safety and Health Administration
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RCRA	Resource Conservation and Recovery Act
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedure
U.S. EPA	United States Environmental Protection Agency

1.0 SCOPE & METHOD SUMMARY

This Standard Operating Procedure (SOP) describes the basic techniques and general considerations to be followed for the packaging and shipment of environmental samples consisting of water, soil, sediment and any other matrix sampled and submitted for routine environmental testing.

This SOP is designed to provide a high degree of certainty that environmental samples will arrive at their destination intact. While the majority of the samples are delivered via laboratory courier, this SOP assumes that samples will often require shipping overnight by a commercial carrier service; therefore, the procedures are more stringent than may be necessary.

Sample packaging and shipment involves the placement of individual sample containers into a cooler or other similar shipping container and placement of packing materials and coolant in such a manner as to isolate the samples, maintain the required temperature, and to limit the potential for damage to sample containers when the cooler is transported

It is expected that the procedures outlined in this SOP will be followed. Procedural modifications may be warranted depending on field conditions, equipment limitations, or limitations imposed by the procedure. Substantive modification to this SOP will be noted in task-specific work plans or on Field Modification Forms as appropriate and will be approved in advance by the Task Manager and the Project QA Manager. Deviations from the SOP will be documented in the project records and in subsequent reports. The ultimate procedure employed will be documented in the report summarizing the results of the sampling event or field activity.

2.0 PERSONNEL QUALIFICATIONS

Sample packaging and shipment is a relatively simple procedure requiring minimal training and a minimal amount of equipment. It is recommended that initial attempts be supervised by more experienced personnel.

Personnel who will work on sites where hazardous waste materials may be present will be health and safety certified as specified by the *Occupational Safety and Health Administration (OSHA) (29 CFR 1910.120(e)(3)(i))*..

It is the responsibility of the field personnel to be familiar with the procedures outlined within this SOP, quality assurance, and health and safety requirements outlined within this *Sampling and Analysis Plan* (SAP) (Enbridge, 2011a), the *Quality Assurance Project Plan* (QAPP) (Enbridge, 2011b), and the *Health and Safety Plan* (HASP) (Enbridge, 2010). Field personnel are also responsible for proper documentation in the field logbook.

3.0 HEALTH AND SAFETY

The health and safety considerations for the work associated with this SOP, including both potential physical and chemical hazards, are addressed in the site specific HASP. All work will be conducted in accordance with the HASP.

4.0 INTERFERENCES

Sample containers with presumed high constituent concentrations should be isolated within their own cooler with each sample container placed into a zipper-lock bag.

5.0 EQUIPMENT & SUPPLIES

The following equipment list contains materials which may be needed in carrying out the procedures contained in this SOP. Not all equipment listed below may be necessary for a specific activity. Additional equipment may be required, pending field conditions.

- Sample coolers,
- Sample containers,
- Shipping labels,
- Chain of custody (COC) form,
- Bubble wrap,
- Vermiculite (granular), or Styrofoam pellets,
- Wet ice,
- Temperature blank,
- Transparent tape,
- Custody seal for the outside of the cooler,
- Fiberglass packaging tape,
- Duct tape,
- Scissors,
- Zipper-lock plastic bags (gallon and quart sizes),
- Trash bags,
- Health and safety supplies (as required by the HASP), and
- Field project logbook/pen with indelible ink.

Approved

6.0 METHODS

6.1 Preparation

The extent and nature of sample containerization will be governed by the type of sample, and the most reasonable projection of the sample's hazardous nature and constituents. *United States Environmental Protection Agency (U.S. EPA) regulations (40 CFR Section 261.4(d))* specify that samples of solid waste, water, soil or air, collected for the sole purpose of testing, are exempt from regulation under RCRA when any of the following conditions are applicable:

- Samples are being transported to a laboratory for analysis;
- Samples are being transported to the collector from the laboratory after analysis;
- Samples are being stored (1) by the collector prior to shipment for analyses, (2) by the analytical laboratory prior to analyses, or (3) by the analytical laboratory after testing but prior to return of sample to the collector or pending the conclusion of a court case.

6.1.1 Sample Information

The following information must accompany each shipment of samples on a chain of custody form where each sample has an individual entry:

- Sample collector's name, mailing address and telephone number,
- Analytical laboratory's name, mailing address and telephone number,
- A unique identification of each sample,
- Sample description (matrix),
- Number and type of sample containers,
- Container size,
- Preservative,
- Type and method of analysis requested,
- Date and time of sample collection, and
- Special handling instructions, including notation of suspected high concentration samples.

6.1.2 Laboratory Notifications

Prior to sample collection, the Task Manager or designee must notify the laboratory project manager of the number, type, and approximate collection and shipment dates for the samples. If the number, type, or date of sample shipment changes due to program changes that may occur in the field, the Task Manager or alternate must notify the laboratory of the changes.

Additional notification from the field is often necessary when shipments are scheduled for weekend delivery.

6.1.3 Cooler Inspection and Decontamination

Laboratories will often re-use coolers. Every cooler received at a project location should be inspected for condition and cleanliness. Any coolers that exhibit cracked interiors or exterior linings/panels or hinges should be discarded because the insulating properties of the coolers would be considered compromised. Any coolers missing one or both handles should also be discarded if replacement handles (*i.e.*, knotted rope handles) cannot be fashioned in the field.

The interior and exterior of each cooler should be inspected for cleanliness before using it. Excess strapping tape and old shipping labels should be removed. If the cooler interior exhibits visible contamination or odors it should not be used. Drain plugs should be sealed on the inside and outside with duct tape.

6.2 Sample Packaging

Place plastic bubble wrap matting over the base of each cooler or shipping container as needed. A 2- to 3-inch thick layer of vermiculite may be used as a substitute base material. Line the inside of the cooler using a large trash bag with the open end up.

Check that each sample container is sealed, labeled legibly, and is externally clean. Re-label and/or wipe bottles clean if necessary. Place all sample containers in bubble wrap bags and seal the bag using either the adhesive strip on the bag or tape. Place bottles into the cooler (inside the trash bag) in an upright single layer with approximately one inch of space between each bottle. Do not stack bottles or place them in the cooler lying on their side. If plastic and glass sample containers are used, alternate the placement of each type of container within the cooler so that glass bottles are not placed side by side if possible.

Insert the cooler temperature blank supplied by the laboratory into each cooler (if any).

If needed, place additional vermiculite, bubble wrap, and/or Styrofoam pellet packing material throughout the voids between sample containers within each cooler to a level that meets the approximate top of the sample containers. Packing material may require tamping by hand to reduce the potential for settling.

Bag wet ice into gallon-size zipper-lock bags to ensure no leaking occurs during shipment. Insert the bags of ice around, between, and on top of the sample containers. Sufficient ice should be used to maintain the sample temperature at 4° Celsius (C) during shipping. Close and seal the large trash bag that lines the cooler by twisting the open end and taping or knotting the bag closed to prevent the cooler from leaking throughout the shipping process.

Add additional bubble wrap/Styrofoam pellets or other packing materials to fill the balance of the cooler or container.

Complete the COC form per *SOP EN-102 – Chain of Custody Procedures.* If shipping the samples involves use of a third party commercial carrier service, sign the COC record thereby relinquishing custody of the samples. Shippers should not be asked to sign COC records. If a laboratory courier is used, or if samples are transported to the laboratory by field personnel, the receiving party should accept custody and sign the COC records. Remove the last copy from the multi-form COC and retain it with other field notes. If an electronically produced COC is used, make copies of the COC (only after all signatures are in place). Place the original (with remaining copies) in a zipper-lock plastic bag and tape the bag to the inside lid of the cooler or shipping container.

Close the lid of the cooler or the top of the shipping container.

If shipping samples via third party commercial carrier service (*e.g.*, FedEx), obtain COC tape or custody seals and enter the custody tape/seal number(s) in the appropriate place on the COC form. Sign and date the COC tape/seals. If the samples are being transported via laboratory courier, COC tape or custody seals are not required.

When placing COC tape or a signed and dated custody seal on the cooler, place it with half of the seal on the lid and the other half on the body of the cooler.

Packaging tape should be placed entirely around the sample shipment containers. A minimum of two full wraps of packaging tape will be placed at least two places on the cooler/container. The custody seal should be underneath one of the wraps of packaging tape.

Repeat the above steps for each cooler or shipping container.

6.3 Sample Shipping

Transport the cooler/container to the package delivery service office or arrange for package pick-up at the site. Fill out the appropriate shipping form or air bill and affix it to the cooler/container. Some courier services may use multi-package shipping forms where only one form needs to be filled out for all packages going to the same destination. However, separate shipping form should be used for each cooler/container, the multi-package shipping forms should not be used when shipping environmental samples. The receipt for package tracking purposes should be kept in the project files, in the event a package becomes lost.

Each cooler/container also requires a shipping label that indicates point of origin and destination. This will aid in recovery of a lost cooler/container if a shipping form gets misplaced.

Never leave coolers/containers unattended while waiting for package pick-up.

Air bills or way bills will be maintained as part of the custody documentation in the project files.

6.4 Sample Receipt

Upon receipt of the samples, the analytical laboratory will open the cooler or shipping container and will sign "received by laboratory" on each COC form. The laboratory will verify that the COC tape has not been broken previously and that the COC tape/seal number corresponds with the number on the COC record. The laboratory will note the condition of the samples upon receipt and will identify any discrepancies between the contents of the cooler/container and COC. The analytical laboratory will then forward the back copy of the COC record to the project Quality Assurance (QA) Officer to indicate that sample transmittal is complete.

7.0 DATA & RECORDS MANAGEMENT

The data associated with packaging and shipment of environmental samples is contained within the following:

- Sample labels,
- Chain of custody records and custody seal(s),
- Field logbook, and
- Sample collection records.

The following SOPs describe the data collection and record management procedures that should be followed as part of the packaging and shipment of environmental samples process:

- *SOP EN-101 Field Records, and*
- *SOP EN-102 Chain of Custody Procedures.*

See the referenced SOPs for additional details.

Approved

8.0 QUALITY CONTROL & QUALITY ASSURANCE

Quality Control (QC) samples used in association with packaging and shipment of environmental samples include trip blanks and temperature blanks. See the QAPP for frequency of use and methods.

Approved

9.0 REFERENCES

Enbridge, 2011a. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Sampling and Analysis Plan (SAP). August 30, 2011.

Enbridge, 2011b. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Quality Assurance Project Plan (QAPP). August 19, 2011.

Enbridge, 2010. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Health and Safety Plan (HASP). August 2010.

SOP EN-101 – Field Records

SOP EN-102 – Chain of Custody Procedures

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Survey – SOP EN-104

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LIST OF ACRONYMS

DGPS	Differential Global Positioning System
DOP	Dilution of Precision
GIS	Geographic Information System
GPS	Global Positioning System
HASP	Health and Safety Plan
HDOP	Horizontal Dilution of Precision
PDOP	Position Dilution of Precision
PPEST ACC	Post Proving Estimated Accuracy
QAPP	Quality Assurance Project Plan
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedure
Project	The Enbridge Line 6B MP 608 Marshall, Michigan Pipeline Release
U.S. EPA	United States Environmental Protection Agency
WAAS	Wide Area Augmentation System

Approved

1.0 SCOPE AND METHOD SUMMARY

This Standard Operating Procedure (SOP) describes the basic techniques and general considerations to be followed for the collection of horizontal coordinates of sample locations using a Differential Global Positioning System (DGPS) associated with the Enbridge Line 6B MP 608 Marshall, Michigan Pipeline Release (Project) operations, post-processing of the DGPS data, and horizontal accuracy requirements for the coordinate data. Post processing provides a higher level of accuracy by eliminating most DGPS errors by comparing and baselining simultaneous location data from the DGPS receiver and a nearby DGPS base station. This SOP will ensure that the DGPS data has been post-processed reviewed, and locations re-surveyed if necessary if the accuracy standard has not been meet.

2.0 PERSONNEL QUALIFICATIONS

It is the responsibility of the field personnel to be familiar with the procedures outlined in this SOP. The field personnel will be trained in both the use of the global positioning system (GPS) equipment, as well as the task specific data collection protocols which are being utilized for the specific task. It is also the responsibility of the field personnel to be familiar with the procedures outlined within this *Sampling and Analysis Plan (*SAP*)* (Enbridge, 2011a)*,* specific instrument operations manuals, the *Quality Assurance Project Plan (*QAPP*)* (Enbridge, 2011b)*,* and the *Health and Safety Plan (*HASP*)* (Enbridge, 2010)*.*

3.0 HEALTH AND SAFETY

The health and safety considerations for the work associated with this SOP, including both potential physical and chemical hazards, is addressed in the site specific HASP. All work will be conducted in accordance with the HASP.

4.0 INTERFERENCES

Potential interferences which could decrease the accuracy of DGPS data include:

- Not allowing enough time for the DGPS receiver to collect enough position fixes to accurately estimate location,
- Obstacles that may block or degrade the transmission of data from the satellites to the DGPS rover, such as buildings and tree canopy,
- Collecting DGPS data when position dilution of precision (PDOP) or horizontal dilution of precision (HDOP) are higher, potentially causing a greater range of error, and
- Not having a connection to the Wide Area Augmentation System (WAAS) differential correction satellite in the field.

5.0 EQUIPMENT AND SUPPLIES

The following equipment list contains materials which may be needed in carrying out the procedures contained in this SOP. Not all equipment listed below may be necessary for a specific activity.

- Mapping grade GPS rover and Antenna capable of post-processing to sub-foot accuracy (such as Trimble Yuma® and ProXH receiver, Trimble GeoXH Handheld, or equivalent unit),
- GPS software capable of downloading and post-processing the DGPS data (such as ESRI Arcpad and Trimble GPS Correct, Trimble GPS Analyst for ArcGIS or equivalent software), and
- Site maps and digital Geographic Information System (GIS) data

6.0 METHODS

6.1 Data Collection

Regardless of the type of DGPS rover used, the following steps should be followed to minimize positioning errors while collecting data:

- The field personnel responsible for collected the DGPS data should check the dilution of precision (DOP) chart for that day using a software program (such as Trimble's® Planning Software, http://www.trimble.com/planningsoftware_ts.asp) to see the variations in DOP.
- On the DGPS rover, the DOP settings should be set to a maximum of 6.0 to allow for more accurate position fixes.
- When DGPS data is being collected at a particular location, the field personnel shall allow a minimum of 20 position fixes to be obtained.
- Minimum satellite elevation angle should be set to 15° to allow for more accurate position fixes.
- The DGPS antenna shall be placed in a static position and not moved during the occupation period.

6.2 Post-Processing of Data

After each day of sample location data collection, the DGPS rover shall be returned to the office and the DGPS data files transferred to the server. The raw DGPS data files shall be saved in the appropriate file folder in the server. After the transfer the DGPS files on the rovers shall be deleted.

Once the raw DGPS data file is saved on the server, the data file must then be post-processed to eliminate positional errors by using location data collected simultaneously from a base station. During post-processing the closest base station with the greatest percentage of coverage shall be used to correct the DGPS data. The corrected DGPS data files will be downloaded and saved in the same folder. Each file should have a new field added Post Proving Estimated Accuracy (PPEST ACC). This field will be used to store the estimated accuracy obtained during the post-processing procedure.

6.3 Level of Accuracy Review

A GPS report will be generated for each data file and will present, at a minimum, for each point:

- Location ID (sample ID),
- Corrected X and Y coordinates,
- Post-processed estimated accuracy,
- PDOP and HDOP,
- Number of satellites,
- Age of differential fix, and
- GPS time and date,

This SOP establishes a maximum post-processed accuracy of one meter for collected DGPS data.

If it is found that any location exceeds the one meter maximum accuracy, then that location will be reviewed to determine if it is feasible or necessary to re-survey.

If it is found that the location cannot be re-surveyed accurately (i.e. tree canopy cover, near buildings, etc.) then that location shall be re-surveyed by a professional surveyor to a horizontal accuracy of 0.1-feet.

7.0 DATA AND RECORDS MANAGEMENT

Both the raw and post-processed DGPS files shall be saved in the appropriate folders on the server. In addition, a GPS report shall be generated (discussed above) for each DGPS file and also saved with the raw and post-processed data files on the server.

8.0 QUALITY ASSURANCE AND QUALITY CONTROL

DGPS data files will be double-checked in the field by the field team members on the same day that the data was collected to verify the information is correct.

All GPS data shall be logged into the *Field GPS Data Collection Log* which will reflect the following information:

- Date of collection,
- Mile Post/site,
- Field event type,
- Software used for data collection,
- Collection team,
- GIS Technician doing the download/post processing,
- Post processed status, and
- Network location of data.

Compiled GPS reports will be reviewed by the GPS/GIS technician and doubled-checked by the Project QA Manager or their designees to verify that the accuracy requirements are being met. When the review is complete, the reviewers will append his/her initials and date to the pages reviewed for documentation purposes.

If information recorded in the field pertaining to the GPS survey is transcribed to another format (i.e., field notes), the original record will be retained for reference purposes.

9.0 REFERENCES

Enbridge, 2011a. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Sampling and Analysis Plan (SAP). August 30, 2011.

Enbridge, 2011b. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Quality Assurance Project Plan (QAPP). August 19, 2011.

Enbridge, 2010. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Health and Safety Plan (HASP). August 2010.

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Enbridge Line 6B MP 608

Marshall, MI Pipeline Release

Decontamination of Field Equipment SOP EN-105

Enbridge Energy, Limited Partnership

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LIST OF ACRONYMS

HASP	Health and Safety Plan
IDW	Investigation Derived Waste
QC	Quality Control
QAPP	Quality Assurance Project Plan
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedure

Approved

1.0 SCOPE & METHOD SUMMARY

This Standard Operating Procedure (SOP) describes the methods to be used for the decontamination of field equipment used in the collection of environmental samples. Field equipment for decontamination may include a variety of items used in the field for monitoring or for collection of soil, sediment, and/or water samples, such as water level meters, water quality monitoring meters (turbidity meter, multi-parameter meter), split-spoon samplers, trowels, scoops, spoons, and pumps. Heavy equipment such as a drill rig also requires decontamination, usually in a specially constructed temporary decontamination area.

Decontamination is performed as a quality assurance measure and a safety precaution. Improperly decontaminated sampling equipment can lead to misinterpretation of environmental data due to interference caused by cross-contamination between samples or sample locations through use of contaminated equipment. Decontamination also protects field personnel from potential exposure to hazardous materials on equipment.

Decontamination is accomplished by manually scrubbing, washing, or spraying equipment with detergent solutions, tap water, distilled/deionized water, and/or solvents.

Generally, decontamination of equipment is accomplished at each sampling site between collection points. Waste decontamination materials such as spent liquids and solids will be collected and managed as investigation derived waste (IDW) for later management and/or disposal (refer to procedures outlined *SOP EN-106 (Investigative Derived Waste Management))*. All decontamination materials, including wastes, should be stored in central location(s) so as to maintain control over the materials used or produced throughout the investigation program.

This SOP emphasizes decontamination procedures to be used for decontamination of reusable field equipment. Dedicated or disposable equipment will not be decontaminated.

It is expected that the procedures outlined in this SOP will be followed. Procedural modifications may be warranted depending on field conditions, equipment limitations, or limitations imposed by the procedure. Substantive modification to this SOP will be noted in task-specific work plans or on Field Modification Forms as appropriate and will be approved in advance by the Task Manager. Deviations from the SOP will be documented in the project records and in subsequent reports.

2.0 PERSONNEL QUALIFICATIONS

Decontamination of field equipment is a relatively simple procedure requiring minimal training.

Field personnel must be health and safety certified as specified by the *Occupational Safety and Health Administration (29 CFR 1910.120(e)(3)(i))* to work on sites where hazardous materials may be present.

It is the responsibility of field personnel to be familiar with the decontamination procedures outlined within this SOP, quality assurance, and health and safety requirements outlined within this *Sampling and Analysis Plan (SAP)* (Enbridge, 2011a)*, the Quality Assurance Project Plan (QAPP)* (Enbridge, 2011b)*,* and *the Health and Safety Plan (HASP)* (Enbridge, 2010). Field personnel are responsible for decontamination of field equipment and for proper documentation in the field logbook or electronic data collector such as the Trimble Yuma® (or equivalent).

3.0 HEALTH AND SAFETY

The health and safety considerations for the work associated with this SOP, including both potential physical and chemical hazards, is addressed in the site specific HASP. All work will be conducted in accordance with the HASP.

4.0 INTERFERENCES

Equipment decontamination should be performed at a safe distance away from the sampling area so as not to interfere with sampling activities, but close enough to the sampling area to maintain an efficient working environment.

5.0 EQUIPMENT & SUPPLIES

The following equipment list contains materials which may be needed in carrying out the procedures contained in this SOP. Not all equipment listed below may be necessary for a specific activity. Additional equipment may be required, pending field conditions.

- Decontamination agents;
  - ALCONOX®, or other non-phosphate and non-borate biodegradable detergent,
  - Tap water, and
  - Distilled/deionized water.
- Health and safety supplies (as required by the HASP);
- Chemical-free paper towels;
- Waste storage containers: drums, 5-gallon buckets with covers, plastic bags;
- Cleaning containers: plastic buckets or tubs ;
- Cleaning brushes;
- Pressure sprayers;
- Squeeze/spray bottles;
- Plastic sheeting;
- Zipper-lock bags and/or foil wrap; and
- Field project logbook/pen with indelible ink.

6.0 METHODS

6.1 General Preparation

New materials, such as well materials, are generally assumed to be clean and decontamination is not anticipated. However, they should be inspected and if they appear to be dirty, should be decontaminated.

Small pre-cleaned field equipment can be stored in zipper-lock plastic bags or foil wrap in a designated "clean" area to eliminate the potential for contamination. Field equipment should be inspected and decontaminated prior to use if the equipment appears dirty.

Heavy equipment (drill rigs, Geoprobes®, excavators) should be decontaminated prior to beginning any work.

Pre-established IDW containment stations should be used to discard IDW between sampling locations.

6.2 Decontamination for Sampling Equipment

This procedure applies to equipment used in the collection of environmental samples and other field equipment. Examples of relevant items of equipment include split-spoons, trowels, scoops, spoons, and other small items. Submersible pump decontamination procedures are outlined in Section 6.3.

- Decontamination is to be performed before sampling events, between sampling points, and at the end of the day unless otherwise noted in the work plan. After a sample has been collected, remove all gross contamination from the equipment or material by brushing and then rinsing with available tap water. This initial step may be completed using a 5-gallon bucket filled with tap water or by spraying/pouring tap water over the equipment in to a bucket. A water pressure sprayer may also be used to remove solids and/or other contamination.
- Wash the equipment with a non-phosphate and non-borate detergent and tap water solution. This solution should be kept in a 5-gallon bucket with a dedicated brush. Isopropyl alcohol may also be used to remove any contamination that may not be easily

removed with detergents. If isopropyl alcohol is used, the equipment must be washed again using a detergent.

- Rinse with tap water or distilled/deionized water until all detergent and other residue is washed away. This step can be performed over an empty bucket using a squeeze bottle, pressure sprayer or by directly pouring the distilled/deionized water over the equipment.
- Place the equipment on a clean surface (foil or plastic) and allow the equipment to air-dry in a clean area or blot with chemical-free paper towels before reuse.All decontaminated equipment should be placed in a clean plastic bag, clean pail, or wrapped in foil once it is dry if it is being stored.
- Dispose of soiled materials and spent solutions in the designated IDW disposal containers.

6.3 Decontamination of Submersible Pumps

This procedure will be used to decontaminate submersible pumps before and between groundwater sample collection points. This procedure applies to both electric submersible and bladder pumps. This procedure also applies to discharge tubing if it will be reused between sampling points.

- Prepare the decontamination area if pump decontamination will be conducted next to the sampling point. If decontamination will occur at another location, the pump and tubing may be removed from the well and placed into a clean trash bag for transport to the decontamination area.
- Once the decontamination station is established, the pump should be removed from the well and the discharge tubing and power cord coiled by hand as the equipment is removed. If any of the equipment needs to be put down temporarily, it should be placed on a plastic sheet (around well) or in a clean trash bag. If a disposable discharge line is used it should be removed and discarded at this time.
- As a first step in the decontamination procedure, use a pressure sprayer with tap water to rinse the exterior of the pump, discharge line, and power cord as necessary. Collect the rinsate and handle as IDW.
- Place the pump into a bucket containing a detergent solution (phosphate-free, borate-free detergent in tap water). Holding the tubing/power cord, pump solution through the

pump system. A minimum of one gallon of detergent solution should be pumped through the system. Collect the rinsate and handle as IDW.

- Remove the pump from the bucket and if the pump is reversible, place the pump in the reverse mode to discharge all removable water from the system. If the pump is not reversible the pump and discharge line should be drained by hand as much as possible. Collect the rinsate and handle as IDW.
- Place the pump into a clean bucket containing distilled/deionized water. Holding the tubing/power cord, pump the distilled/deionized water through the pump and tubing to remove any detergent residue that may remain inside the pump and tubing. Using a pressure sprayer with distilled/deionized water, rinse the exterior of the pump, discharge line, and power cord thoroughly, shake off all excess water, and then place the pump system into a clean trash bag for storage. Collect the rinsate and handle as IDW.

6.4 Decontamination of Large Equipment

A temporary decontamination pad may be established for decontamination of heavy equipment. This pad may include a membrane-lined and bermed area large enough to drive heavy equipment (e.g., drill rig, backhoe) onto with enough space to spread equipment and to contain overspray. Usually a small sump is necessary to collect and contain rinsate (a pump is used to remove these wastes from the sump). A water supply and power source is also necessary to run steam cleaning and/or pressure washing equipment.

Upon arrival at the area of investigation, all heavy equipment (such as drill rigs) should be thoroughly cleaned. This can be accomplished by steam cleaning or high pressure water wash and manual scrubbing.

Between each sample location (*i.e.*, between boreholes), heavy equipment that has been in the ground must be cleaned by steam cleaning or high pressure water wash and manual scrubbing. This may be performed at the decontamination pad or in the vicinity of the drilling location.

7.0 DATA & RECORDS MANAGEMENT

The data associated with decontamination procedures includes the following:

- Date, time, and location of each decontamination event,
- Equipment decontaminated,
- Method,
- Detergents used,
- Notable circumstances,
- Identification of equipment rinsate blanks,
- Management of decontamination fluids,
- Method, date, and time of equipment blank collection, and
- Disposition of IDW.

Repetitive decontamination of small items of equipment does not need to be logged each time the item is cleaned.

The records generated in this procedure will become part of the permanent record supporting the associated field work. All documentation will be retained in the project files following project completion.

Approved

8.0 QUALITY ASSURANCE AND QUALITY CONTROL

Quality Control (QC) samples collected in association with decontamination of field equipment may include equipment rinsate blanks. See the QAPP for collection frequency and methods.

9.0 REFERENCES

Enbridge, 2011a. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Sampling and Analysis Plan (SAP). August 30, 2011.

Enbridge, 2011b. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Quality Assurance Project Plan (QAPP). August 19, 2011.

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SOP EN-106 – Investigative Derived Waste Management.

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Investigative Derived Waste Management– SOP EN-106

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LIST OF ACRONYMS

DOT	Michigan Department of Transportation
Enbridge	Enbridge Energy, Limited Partnership
HASP	Health and Safety Plan
IDW	Investigation Derived Waste
MDEQ	Michigan Department of Environmental Quality
MS/MSD	Matrix Spike/Matrix Spike Duplicates
OSHA	Occupations Safety and Health Administration
PPE	Personal Protective Equipment
QAPP	Quality Assurance Project Plan
QC	Quality Control
RCRA	Resource Conservation and Recovery Act
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedure
State	State of Michigan
U.S. EPA	United States Environmental Protection Agency

1.0 SCOPE & METHOD SUMMARY

This Standard Operating Procedure (SOP) describes the methods to be used for the collection, containerization, transport, and disposal of waste generated during field investigations. Types of investigation-derived waste (IDW) may include, but are not limited to, personal protective equipment (PPE); disposable sampling equipment; purge water generated from wells during monitoring events; well development water; extra sample volume not required for analysis in the form of soil, sediment or water; soil cuttings from the installation of wells or soil borings; decontamination fluids, etc.

IDW management is accomplished by appropriately containing, collecting, packaging, characterizing and disposing of the waste. The following guidance documents were used in the development of this SOP:

- *REM III Program Guidelines, Field Technical Guidelines 12.02 (United States Environmental Protection Agency (U.S. EPA), 1987)*
- *Management of Investigation-Derived Waste During Site Inspections (U.S. EPA, 1991a)*
- *Standard Operating Procedures and Quality Assurance Manual, Section 4.5 (U.S. EPA, 1991b)*

It is expected that the procedures outlined in this SOP will be followed by all personnel during activities that generate and/or manage IDW. Procedural modifications may be warranted depending on field conditions, equipment limitations or limitations imposed by the procedure. Substantive modification to this SOP will be noted in task-specific work plans or on Field Modification Forms as appropriate and will be approved in advance by the Task Manager. Deviations from the SOP will be documented in the project records and in subsequent reports.

2.0 PERSONNEL QUALIFICATIONS

The management of IDW is a relatively involved procedure requiring specific training. Personnel trained in the containment, characterization, transport and disposal of IDW will oversee IDW management on this project.

Field personnel must be health and safety certified as specified by the *Occupational Safety and Health Administration (OSHA) (29 CFR 1910.120(e)(3)(i))* to work on sites where hazardous materials may be present.

It is the responsibility of field personnel to be familiar with the IDW management procedures outlined within this SOP as well as quality assurance and health and safety requirements outlined within this *Sampling and Analysis Plan (SAP)* (Enbridge, 2011a), the *Quality Assurance Project Plan (QAPP)* (Enbridge, 2011b), and the *site-specific Health and Safety Plan (HASP)* (Enbridge, 2010).

3.0 HEALTH AND SAFETY

The health and safety considerations for the work associated with this SOP, including both potential physical and chemical hazards, is addressed in the site specific HASP. All work will be conducted in accordance with the HASP.

4.0 INTERFERENCES

Not Applicable.

5.0 EQUIPMENT & SUPPLIES

The following equipment list contains materials which may be needed in carrying out the procedures contained in this SOP. Not all equipment listed below may be necessary for a specific activity. Additional equipment may be required, pending field conditions.

- Sample kit (i.e., bottles, labels, preservatives, custody records and tape, cooler, ice),
- Sample chain of custody forms (as required by *SOP EN-102 – Chain of Custody Procedures)*,
- Sample packaging and shipping supplies (as required by *SOP EN-103 – Packaging and Shipment of Environmental Samples)*,
- Drum labels,
- Waterproof marker or paint,
- Paper towels,
- Trash bags,
- Health and safety supplies (as required by the *HASP)*,
- Field logbook and pen,
- Drums, tubs, totes, and other receptacles used to contain IDW, and
- Drum bung wrench, drum lid ring's deep well socket and socket wrench.

6.0 METHODS

In the process of collecting environmental samples during field investigation activities, many different types of IDW may be generated. Some of these waste materials may be hazardous wastes which must be properly managed in accordance with U.S. EPA and State of Michigan (State) regulations. To properly handle IDW in compliance with agency regulations, reasonable efforts should be made to characterize the wastes as non-hazardous or hazardous and to determine if the IDW has been mixed with a listed waste.

Resource Conservation and Recovery Act (RCRA) procedures for determining whether a waste exhibits *RCRA* hazardous characteristics do not require sampling and analysis if the decision can be made by "applying knowledge of the hazard characteristic in light of the materials or process used" *(40 CFR 262.11(c))*. The nature of the waste should be assessed by applying best professional judgment and using readily available information about the site (such as manifests, storage records, preliminary assessments, and results of earlier studies that may have been conducted and are available, as well as direct observation of the IDW for discoloration, or other indicators of contamination). The U.S. EPA has specifically indicated that IDW may be assumed to not be a "listed" waste under *RCRA* unless available information about the site suggests otherwise *(53 FR 61444, December 21, 1988)*.

6.1 General

Upon designating IDW as either RCRA hazardous or RCRA non-hazardous using existing information and best professional judgment practices, the Task Manager should assure that appropriate handling procedures have been developed.

6.1.1 Management of Non-Hazardous IDW

Non-hazardous IDW such as PPE and disposable equipment may be bagged and transported to a local permitted municipal landfill. Non-hazardous IDW such as drill cuttings, purge or development water, decontamination fluids, etc., will be containerized, managed appropriately while on site, and transported to an appropriately licensed off-site disposal facility. Waste hauling services should be obtained and waste storage locations maintained at the project site pending transport.

Purge water from monitoring wells which have already been analyzed and are shown to be below Residential Drinking Water Criteria may be discharged to the ground surface away from the monitoring well unless otherwise prohibited by site protocol.

Purge water from private potable wells which are in use may be discharged directly to the ground surface.

6.1.2 Management of Hazardous IDW

Hazardous IDW must be managed as specified in applicable U.S. EPA and Michigan Department of Environmental Quality (MDEQ) regulations. Management of hazardous waste includes both proper handling and disposal within the required time frame in accordance with requirements for small or large quantity generators, as applicable. IDW should be disposed off-site in an appropriately licensed and approved hazardous waste landfill or liquid waste treatment facility. IDW designated for off-site disposal must be properly containerized, characterized, labeled, and stored before transport and disposal.

On-site management of hazardous IDW requires special precautions and planning.

Generation of hazardous IDW should be kept to a minimum. Disposable equipment and PPE can often be cleaned to render it non-hazardous. Decontaminated PPE and disposable equipment should be bagged if sent to an off-site dumpster or a municipal landfill.

6.2 Waste Segregation

If it is determined by the Field Manager that off-site disposal of IDW is required, liquid waste should be contained separately from solid waste for ease of handling. For this SOP, liquid wastes include purge and well development water, while solid wastes include soil, drilling mud, and sampling debris. If drums are used for containing the IDW, the Field Sampling Team Leader is responsible for noting in the field logbook, the waste type in each drum and for labeling the drums.

6.2.1 Solids

Solid waste to be containerized should be placed in -Department of Transportation (DOT)-specified, 17H 55-gallon drums (or similar), lined roll off boxes or an appropriately constructed containment building. Under no circumstances should solid residues from a known “hot spot” be combined with other residues containing suspected but unknown contamination, regardless of whether the drum is filled or not. To minimize the number of drums (if used), “hot spot” residues containing similar waste characteristics can be combined. Also, for the collection of solid waste, allow at least 6 to 12 inches of empty space in each drum if the addition of absorbent is necessary. The following solid matter should be handled as described:

- **Soil Cuttings/Excess Soil/Sediment Sample Volume** - Soil cuttings or excess soil/sediment volume may be stockpiled at the site, placed in DOT-specified drums, or placed in roll-off boxes or other containers pending transportation. Drums containing soil or sediment should be identified with a particular boring, well, or test pit from which the material was generated. To minimize the number of drums generated during an investigation, soils from several sources in the same general location can be placed in the same drum with proper labeling. Documentation must be maintained to identify the source of the soils (including boring ID and depths) containerized in a particular drum for correlation to laboratory data for future disposal. The description of the waste/soil, boring location, and general observations should also be noted in the field logbook. Soil cuttings from soil borings or well installation activities and sediment associated with sampling efforts will be containerized, labeled, staged for disposal, characterized, and disposed of at an appropriately licensed disposal facility.
- **PPE, Sampling Equipment, and Absorbents** - Used PPE and disposable sampling equipment can be containerized together but separate from other solid (soil/sediment) and liquid waste. Spent PPE and sampling equipment are typically collected on a daily basis in plastic garbage bags and disposed at the end of daily activities in a drum dedicated for this type of waste or in an on-site dumpster. Non-contaminated PPE and materials that do not come in contact with contaminated media can be disposed along with other general waste generated at the site. Soiled absorbents and PPE will be held in drums or roll-off boxes at the major centers of activity on the site or will be containerized, labeled, staged for disposal, characterized, and disposed of at an appropriately licensed disposal facility.

6.2.2 Liquids

For this SOP, liquid waste refers to well development water, purge water and decontamination fluids. Liquid wastes requiring off-site transport and disposal can be containerized using 55-gallon drums, plastic totes, welded tanks, or liquid tanker trucks. The following liquids should be handled as described:

- **Well Purge Water** - Well purge water, which includes development and sampling purge water, if drummed, should be containerized separately from solid waste. Proper documentation shall be maintained to ensure that liquid waste containers specify the source of the purge water in order to correlate representative laboratory analyses with waste contained in a particular drum or container. It is acceptable to mix purge water from different wells, provided that proper documentation is maintained. However, the water quality results of the most contaminated well contributing to the mixed water will determine the proper method of disposal.
- **Decontamination Water and Sample Preservatives** - Decontamination water that includes chemicals used in the decontamination process, such as isopropyl alcohol or hexane, and excess sample preservatives should be containerized separately. Decontamination water is typically collected and disposed of as necessary in a drum(s) dedicated for this type of waste. Steam cleaning rinsate should also be containerized separately from other liquids unless the Field Manager determines that the rinsate is non-hazardous.
- Water generated during well development, well sampling, or decontamination processes will be containerized, labeled, staged, and transported to an appropriately licensed disposal facility.

6.3 On-Site Drum Handling

All filled or partially filled drums must be properly closed, sealed, labeled, and staged before demobilization. If storage is anticipated in excess of two weeks, the drums should be covered with a wind/rain resistant cover such as a plastic or polyethylene tarp.

6.3.1 Absorbent

Soil cuttings that have been containerized will frequently develop a layer of water after being stored on-site for a period of time. If fluids are present in the drums, an absorbent material may be added prior to removal offsite to prevent accidental spillage. This absorbent material can be added during site operations. The absorbing material should consist of an innocuous material such as vermiculite, sawdust, (or fine wood shavings), or some type of kitty litter. The absorbent should be added on the top of the solid waste and not mixed into the waste since the disposal facility may wish to separate the generated solids from the absorbed liquid. The depth and volume or weight of absorbent should be noted in the field logbook.

6.3.2 Staging

All drums shall be staged in a location designated by the Field Manager and approved, in advance, by the Project Manager. Depending upon the accessibility of the site to non-authorized individuals, the staging area may need to be fenced or located inside a larger fenced area. All drums shall be stored on pallets (if possible) in an area where they will stay dry in the case of heavy rain or ponding of water. The drums should be arranged in rows with adequate space between the rows to allow for visual inspection of all drums. The staging area should also be laid out by grouping drums of similar waste together to allow for easier access to waste types during the removal operations, minimizing the need to rearrange drums. Drums should not be stacked on top of each other unless the contents are known to be non-explosive and non-flammable. If stacked, drum layers must be separated using pallets. Under no circumstances should drums be stacked more than two high.

Equipment used to move filled drums may include backhoes, forklifts, front-end loaders or drum grapplers. Caution should be exercised to prevent damaging drums. Any drums found to be damaged or leaking must be overpacked in a leak-proof container.

In the event that drums must be stored on-site for longer than 90 days, precautions such as berms, secondary containment, and/or overpacking should be taken to prevent accidental leakage or environmental corrosion.

6.3.3 Sealing

Proper sealing involves securing and fastening drum rings and bungs. Open-top drums are delivered with the outer ring reversed and fastened with the bolt on the upper side of the drum lid, which is a universal convention indicating an empty drum. When the drums are filled, the drum lid should be secured by placing the ring with the bolt down and tightened over the drum lip. Depending on the access of the site to unauthorized individuals, it may be appropriate to notch or mark the drum and ring to assist in determining whether stored, unsecured drums have been opened. If a drum needs to be opened after sealing, appropriate personal protection shall be required.

6.3.4 Labeling

Initial labeling of all drums shall be performed through the use of an indelible marker on the top and the side of the drum (i.e., grease pens, Rust-Oleum brand or similar spray paint) or by placing a “Pending Analysis” label on the drum. The markings should be at least one inch in height and consist of a number that will allow the drum to be cross-referenced with the field logbook and include type of contents and generation date.

Upon receipt of the sample characterization analyses, final labeling of the drums will occur in accordance with applicable MDEQ and U.S. EPA requirements and Enbridge Energy, Limited Partnership (Enbridge) policy. Factory-purchased labels will be utilized that provides space for the following information:

- Site name and drum log number,
- Material description (soil, sludge, etc.) and generation location (i.e., boring SB2),
- Generator's name and address,
- Generator's temporary ID number,
- Date generated, and
- Manifest or Bill of Lading number (if known).

Waste characterized as hazardous will require a Hazardous Waste label, U.S. EPA generator ID number, and proper transportation manifesting prior to transportation to an approved hazardous waste landfill or treatment facility. Drummed waste shown to be non-hazardous should be returned to the site proper and the drum either returned to the manufacturer (if possible) or properly disposed within the federal, state and local regulations.

6.4 Waste Classification

Prior to removal from a site, all waste must be classified to determine appropriate disposal procedures. Analytical data specifically relating to the drum contents can be used to determine the waste classification. Careful separation of wastes and proper documentation of drum contents may prevent the need for drum sampling if prior waste characterization sampling from the site is available. Additionally, analytical results of samples collected from the site and generator knowledge may also be used to classify waste as hazardous or non-hazardous. The waste disposal facility may also perform their sampling, some of which might be performed on-site prior to removal.

6.5 Drum Removal & Disposal

Drummed wastes will be disposed at an appropriate disposal or treatment facility based upon characterization of the waste. Removal of wastes in drums from a site should be performed only by subcontractors holding permits approved by federal and state authorities to transport hazardous materials. In most cases, the various categories of wastes will be transported to one of several destinations. It is the responsibility of the Project Manager to determine that wastes are properly classified and to know their final destination. Furthermore, the Field Manager must inform the Project Manager of the wastes' final destination and secure from the client written concurrence on use of the disposal facility. Although it is not required, subcontractors may be used to complete the waste profile sheets, classify the waste, perform confirmatory drum sampling, inspect/overpack (if necessary), and complete transportation manifest forms. The manifest forms should be signed by the client or by an authorized representative of the client.

7.0 DATA & RECORDS MANAGEMENT

The data associated with waste characterization includes the following:

- Location, date, and time of waste generation,
- Process which generated the waste,
- Assumed contaminants of concern within waste stream based upon current knowledge,
- Sample(s) collected with associated analytical parameter request,
- Sample ID's,
- Date and time of sample collection,
- Name of person collecting sample(s), and
- Chain of custody(s).

Upon receipt of waste classification results, appropriate transportation and disposal events should occur. The following information should be logged when preparing shipments for transport and disposal:

- Number, type, and quantity of containers being shipped,
- Current storage location(s) of containers,
- Waste approval number,
- Transporter (company) name and ID number,
- Manifest number, and
- Disposal facility name and location.

The records generated in this SOP will become part of the permanent record supporting the associated field work. All documentation will be retained in the project files following project completion.

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8.0 QUALITY ASSURANCE AND QUALITY CONTROL

Quality Control (QC) samples collected may include field duplicates, equipment and/or field blanks, trip blanks, and matrix spike/matrix spike duplicates (MS/MSD). See the QAPP for collection frequency and methods.

9.0 REFERENCES

Enbridge, 2011a. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Sampling and Analysis Plan (SAP). August 30, 2011.

Enbridge, 2011b. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Quality Assurance Project Plan (QAPP). August 19, 2011.

Enbridge, 2010. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Health and Safety Plan (HASP). August 2010.

Environmental Protection Agency, 1987, REM III Program Guidelines, Field Technical Guidelines 12.02, Region II.

Environmental Protection Agency, 1991a, Management of Investigation-Derived Waste During Site Inspections, Office of Research and Development, Washington, DC.

Environmental Protection Agency, 1991b, Standard Operating Procedures and Quality Assurance Manual (Section 4.5), Environmental Compliance Branch, Region IV, Athens, Georgia.

SOP EN-102 – Chain of Custody

SOP EN-103 – Packaging and Shipment of Environmental Samples

Enbridge Line 6B MP 608
Marshall, MI Pipeline Release

Surface Water Sample Collection SOP EN-201

Prepared for Michigan Department of Environmental Quality

Enbridge Energy, Limited Partnership

Submitted: November 11, 2010

Approved: August 30, 2011

Approved

LIST OF ACRONYMS

DO	Dissolved Oxygen
HASP	Health and Safety Plan
MS/MSD	Matrix Spike/Matrix Spike Duplicate
ORP	Oxidation Reduction Potential
OSHA	Occupational Safety and Health Administration
QAPP	Quality Assurance Project Plan
QC	Quality Control
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedure
USGS	United States Geological Survey
VOC	Volatile Organic Compound

Approved

1.0 SCOPE AND METHOD SUMMARY

This Standard Operating Procedure (SOP) describes the basic techniques and general considerations to be followed for the collection of surface water samples from streams, rivers, ponds, and lakes.

It is expected that the procedures outlined in this SOP will be followed. Procedural modifications may be warranted depending on field conditions, equipment limitations, or limitations imposed by the procedure. Substantive modification to this SOP will be noted in task-specific work plans or on Field Modification Forms as appropriate and will be approved in advance by the Task Manager. Deviations from the SOP will be documented in the project records and in subsequent reports.

Surface water sample collection generally involves collection of a representative water sample from a water body (*e.g.*, stream, river, pond, or lake) into an appropriate container. Specific field conditions such as water depth and location are recorded. Field parameters (*e.g.*, pH, specific conductivity, dissolved oxygen (DO), turbidity, oxidation-reduction potential (ORP), and temperature) will be monitored during surface water sample collection if stated in the work plan.

2.0 PERSONNEL QUALIFICATIONS

Surface water sample collection is a relatively involved procedure requiring formal training and a variety of equipment. It is recommended that initial sampling be supervised by more experienced personnel.

Field personnel must be health and safety certified as specified by the *Occupational Safety and Health Administration (OSHA) (29 CFR 1910.120(e)(3)(i))* to work on sites where hazardous materials may be present.

It is the responsibility of field personnel to be familiar with the sampling procedures outlined within this SOP, with specific sampling, quality assurance, and health and safety requirements outlined within this *Sampling and Analysis Plan (SAP)* (Enbridge, 2011a), the *Quality Assurance Project Plan (QAPP)* (Enbridge, 2011b), and *the Health and Safety Plan (HASP)* (Enbridge, 2010). Field personnel are responsible for collecting samples, decontamination of equipment, and proper documentation in the field logbook, field forms, or electronic data collector such as the Trimble Yuma® or equivalent (if appropriate).

3.0 HEALTH AND SAFETY

The health and safety considerations for the work associated with this SOP, including both potential physical and chemical hazards, is addressed in the site specific HASP. All work will be conducted in accordance with the HASP.

4.0 INTERFERENCES

Potential interferences could result from cross-contamination between sample locations or entrainment of non-target material in the samples. Minimization of cross-contamination will occur through the following:

- Collection of samples from downstream to upstream locations (as appropriate),
- Collection of surface water samples prior to sediment samples at individual locations (when applicable),
- The use of clean, decontaminated sampling equipment at each location, and
- Avoidance of material (e.g., re-suspended solids) that is not representative of the medium to be sampled.

5.0 EQUIPMENT AND SUPPLIES

The following equipment list contains materials which may be needed in carrying out the procedures contained in this SOP. Not all equipment listed below may be necessary for a specific activity. Additional equipment may be required, pending field conditions.

- Surface Water Sample Collection Record, field logbook, or electronic data collector,
- Sample chain of custody forms,
- Sample packaging and shipping supplies,
- Equipment decontamination supplies,
- Peristaltic pump,
- Disposable tubing (both for the pump head assembly and for sample collection as appropriate)
- Health and safety supplies (as required by the HASP),
- Waterproof marker pens (Sharpie® or equivalent),
- Rubber boots (waders),
- Individual or multi-parameter meter(s) to measure temperature, pH, specific conductance, DO, ORP, and/or turbidity (if appropriate),
- Instrument calibration solutions and calibration log,
- Sample kit (i.e., bottles, sample bottle holders, labels, preservatives, custody records, custody seals, cooler, and ice), and
- Field notebook/pen.

6.0 METHODS

6.1 Access to Sample Locations

Sample locations are presented in each specific work plan. Samples from the bank of the river are preferred for long term monitoring, so that continuity of sampling can be maintained longer into winter months when boat access may be impractical. Where samples are located near bridges or piers, these structures can provide convenient access for sampling. A boat may be needed to sample locations on lakes/impoundments, as well as some locations on the Kalamazoo River. When boats are used for sampling, health and safety procedures as described in the HASP must be followed. Wading to locations may be considered, but is not the preferred method in the Kalamazoo River. If it is necessary to wade into the water body to obtain a sample, the sampler shall take care to minimize disturbance of bottom sediments and must enter the water body downstream of the sampling location. If sediment in the sample area is disturbed and water becomes turbid, the sampling technician shall wait for the sediments to settle before taking a surface water sample.

Under ideal and uniform constituent dispersion conditions in a flowing stream, the same concentration of each constituent would occur at all points along the cross section. This situation is most likely near the centroid of flow and away from tributary, eddy, or backwater confluences (USGS, 2006). Careful selection of the sample collection location should assure, as nearly as possible, that samples are taken where uniform flow or dispersion and good mixing conditions exist.

6.2 Surface Water Sampling

Surface water sampling procedures were adapted from USGS (2006*)* and modified for site-specific conditions. Surface water samples from the Kalamazoo River, Morrow Lake and other rivers, streams and ponds will be collected using a peristaltic pump and disposable tubing. A new length of tubing will be used for every location sampled. If necessary the tubing may be attached to an extension pole and lowered into the water column to the target depth. For surface water samples collected on the Kalamazoo River and Morrow Lake the general target depth is zero to one foot (ft) below the water surface unless otherwise specified in the work plan. Care should be taken to ensure that the intake end of the sample tubing does not contact the bed of the river, lake, stream ,or pond to minimize the turbidity of the sample. The intake end of the tubing should also not contact the boat (if sampling from a boat) or any other potentially contaminated surface to avoid cross contamination. Air will be purged from the tubing prior to sample collection and field parameter readings. Sample containers will be filled in the order of analysis starting with the most volatile compounds with the metals being collected last. To minimize volatilization, the pump will be operated at a low speed for several minutes to slowly fill the tube with water which will then be drained tothe volatile organic compound sample containers. The pump's speed may be increased to fill the remaining sample containers, provided the pumping rate does not induce turbidity. Water quality indicator parameter readings (e.g. pH, specific conductance, DO, ORP) will be recorded at the time of sample collection.

During cold weather months a peristaltic pump may become difficult or impossible to use, since the disposable tubing may freeze and portions of the river may be frozen over. A dipping method may be used during these months to help facilitate the sampling and maintain a safe work environment. Using an extension pole with a swing sampler attached, insert a clean one liter glass sample container (no cap is required) into the swing sampler and secure it with zip-ties. A weight attached to a long rope may be needed to break a hole in the ice large enough to fit the swing sampler through. Standing a safe distance from the river bank, extend the pole to the appropriate length and dip the swing sampler to the targeted sample depth (0-1 ft). Once the sample container is full, lift the pole and swing it back to the river bank. Carefully decant the surface water into the appropriate sample containers starting with most volatile compounds using caution to not displace preservatives if pre-preserved and collect the metals last. A new 1 liter sample container for dipping should be used at every location. The end of the extension pole with the attached swing sampler should be decontaminated in accordance with *SOP EN-105* between sample locations.

Samples will be collected farthest downstream first, moving upstream so as to minimize the potential influence on water quality caused by disturbance within the water body.

At each sample location, measurements for pH, specific conductivity, temperature, DO, ORP, and/or turbidity will be collected using either an individual or a multi-parameter meter. The depth of water, depth of sample collection, and visual observations including presence and/or absence of oil or oil sheen of the location will be recorded in the field documentation. At some locations, it will not be possible to measure all field parameters if safe work conditions do not allow – examples include measuring depth of water from a bridge near a dam overflow structure.

A portion of the water sample may be filtered in the field prior to preservation for analysis in the laboratory of dissolved fractions (e.g., selected metals). Filtration procedures and equipment (e.g., vacuum filtration, pressure filtration through cartridge) will be determined by the volume of filtrate desired, presence of fine particulates (e.g., silts, clays) and best professional judgment. Selected filtration methods will be described on the sample collection form, field logbook, and/or electronic data collector.

6.3 Sample Handling and Preservation

- Once each sample container is filled, cap and label the container with (at a minimum) the sample identifier, sampler's initials, sampling date and sampling time. Additional information such as preservation information and analytical tests will be added to the sample label as appropriate.
- For samples slated for VOC analysis, confirm that no headspace bubbles are present in the sample container following placement of the cap. If bubbles are observed, recollect the sample.
- Place the sample containers into a cooler and maintain on ice.
- Complete sample chain of custody and other documentation per *SOP EN-102 – Chain of Custody Procedures.*
- Package the samples for shipment to the laboratory per *SOP EN-103 – Packaging and Shipment of Environmental Samples.*

6.4 Equipment Decontamination

Decontamination is necessary for surface water sampling when using the dipping method described above, for water quality instrumentation, and for any other non-disposable equipment used during the surface water sampling process. When equipment decontamination is required SOP EN-105 - Decontamination of Field Equipment will be followed.

7.0 DATA AND RECORDS MANAGEMENT

The data associated with surface water sample collection will be contained in the following:

- Sample labels,
- Chain of custody records and custody seal(s),
- Field logbook,
- Sample collection records,
- Electronic data collection (Trimble Yuma® or equivalent),
- Field Modification Forms (used prior to field work, when required), and
- Nonconformance Records (used after field work, when required).

The following SOPs describe the data collection and record management procedures that should be followed as part of the surface water sample collection process:

- *SOP EN-101 Field Records,*
- *SOP EN-102 Chain of Custody Procedures,*
- *SOP EN-103 Packaging and Shipment of Environmental Samples, and*
- *SOP EN-502 Water Quality Instrumentation.*

See the referenced SOPs for additional details.

8.0 QUALITY ASSURANCE AND QUALITY CONTROL

Quality Control (QC) samples collected in association with surface water samples may include field duplicates, equipment and/or field blanks, trip blanks, and matrix spike/matrix spike duplicates (MS/MSD). See the QAPP for collection frequency and methods.

9.0 REFERENCES

Enbridge, 2011a. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Sampling and Analysis Plan (SAP). August 30, 2011.

Enbridge, 2011b. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Quality Assurance Project Plan (QAPP). August 19, 2011.

Enbridge, 2010. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Health and Safety Plan (HASP). August 2010.

SOP EN-102 – Chain of Custody Procedures.

SOP EN-103 – Packaging and Shipment of Environmental Samples.

SOP EN-105 – Decontamination of Field Equipment.

USGS. 2006. Chapter A4. Collection of Water Samples in National field manual for the collection of water-quality data collection of water samples TWRI Book 9.

Approved

Enbridge Line 6B MP 608

Marshall, MI Pipeline Release

Sediment Sampling – SOP EN-202

Prepared for Michigan Department of Environmental Quality

Enbridge Energy, Limited Partnership

Submitted: November 11, 2010

Approved: August 30, 2011

Approved

LIST OF ACRONYMS

GPS	Global Positioning System
HASP	Health and Safety Plan
MDEQ	Michigan Department of Environmental Quality
MS/MSD	Matrix Spike/Matrix Spike Duplicate
OSHA	Occupational Safety and Health Administration
PID	Photoionization Detector
PPE	Personal Protective Equipment
QAPP	Quality Assurance Project Plan
QC	Quality Control
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedure
U.S. EPA	United States Environmental Protection Agency
VOCs	Volatile Organic Compounds

1.0 SCOPE AND METHOD SUMMARY

This Standard Operating Procedure (SOP) describes the basic techniques and general considerations to be followed for the collection of sediment samples. For the purposes of this SOP, sediment is defined as soil, sand, silt, clay, organic matter, or other materials that accumulate on the bottom of a water body *(U.S. EPA 1998, 2001, and 2005)*. The specific details of actual sample collection are dependent upon local conditions as well as the purpose of the sampling.

Sediment sample collection generally involves collection of a representative sediment sample from, or near, a water body (e.g., stream, wetland, pond, or lake) into an appropriate container(s). Specific field conditions such as water depth and location are recorded. Field observations, such as presence and type of oil sheen and oil will also be recorded.

It is expected that the procedures outlined in this SOP will be followed. Procedural modifications may be warranted depending on field conditions, equipment limitations, or limitations imposed by the procedure. Substantive modification to this SOP will be noted in task-specific work plans or on Field Modification Forms as appropriate and will be approved in advance by the Task Manager. Deviations from the SOP will be documented in the project records and in subsequent reports.

2.0 PERSONNEL QUALIFICATIONS

Sediment sample collection is a relatively involved procedure requiring formal training and a variety of equipment. It is recommended that initial sampling be supervised by more experienced personnel.

Field personnel must be health and safety certified as specified by the *Occupational Safety and Health Administration (OSHA) (29 CFR 1910.120(e)(3)(i))* to work on sites where hazardous materials may be present.

It is the responsibility of the field personnel to be familiar with the sampling procedures outlined within this SOP, with specific analytical sampling procedures, quality assurance, and health and safety requirements outlined within this Sampling and Analysis Plan (SAP) (Enbridge, 2011a), the *Quality Assurance Project Plan* (QAPP) (Enbridge, 2011b), the *Health and Safety Plan* (HASP) (Enbridge, 2010) and work plans under which the sampling will be conducted. Field personnel are responsible for sample collection, decontamination of equipment, and proper documentation in the field logbook, field forms, or electronic data collector such as the Trimble Yuma® or equivalent (as appropriate).

3.0 HEALTH AND SAFETY

The health and safety considerations for the work associated with this SOP, including both potential physical and chemical hazards, is addressed in the site specific HASP. All work will be conducted in accordance with the HASP.

Approved

4.0 INTERFERENCES

Potential interferences could result from cross-contamination between sample locations or entrainment of non-target material in the samples. Minimization of the cross-contamination will occur through the following:

- Approach of sample locations from downstream,
- Collection of surface water samples prior to sediment samples at individual locations and as required,
- The use of clean, decontaminated or dedicated sampling tools at each location in the field and during sediment core processing. Avoidance of material (e.g., re-suspended solids) that is not representative of the medium to be sampled.

5.0 EQUIPMENT AND SUPPLIES

The following equipment list contains materials which may be needed in carrying out the procedures contained in this SOP. Not all equipment listed below may be necessary for a specific activity. Additional equipment may be required, pending field conditions or as specified in a work plan.

- Nautical equipment (anchors, lines, etc.),
- Universal Core® sampler (or similar), Lexan® core tubes (or similar), core tube catchers, core tube caps, aluminum extension rods (water depths less than 20 ft) or a gravity-driven slide hammer (deeper water),
- Petite Ponar® or Ekman dredge sampler,
- Hacksaw, cordless drill, drill bits, and power shears,
- Duct tape,
- Tape measure or survey stadia,
- Equipment decontamination supplies,
- Stainless steel bowls or Pyrex® containers and spoons, or similar disposable containers,
- Health and safety supplies (personal flotation devices, etc., as required by the HASP),
- Waterproof marker pens (Sharpie® or similar),
- Sample kit (i.e., bottles, labels, preservatives, custody records and tape, cooler, ice) or core storage kit (i.e., 5-gallon buckets, garbage bags, paper towels, cooler, ice),
- Sediment Sample Collection Record, field logbook, camera, and electronic data collector,
- Sample chain of custody forms,
- Sample packaging and shipping supplies,
- Field logbook, and
- Access to a boat when required for transportation.

6.0 METHODS

6.1 Access to Sample Locations

Sample locations are presented in each specific work plan. Samples from the bank of the river are preferred for long term monitoring, so that continuity of sampling can be maintained longer into winter months when boat access may not be available. A boat may be needed to sample locations on ponds and the river. When boats are used for sampling, health and safety procedures as described in the HASP must be followed. Wading to locations may be considered, but is not the preferred method in the Kalamazoo River. If it is necessary to wade into the water body to obtain a sample, the sampler shall take care to minimize disturbance of bottom sediments and must enter the water body downstream of the sampling location.

6.2 Sample Location

Sample location will be identified with a Global Positioning System (GPS) unit as discussed in SOP EN-104 - Survey. Pre-determined GPS identification numbers and coordinates will be used to determine correct sample placement whenever possible. Consideration must be given to maintain the sample location while sampling from boats; the use of anchors and other stabilizing devices may be required to help maintain a sample location. A measuring tape or measuring rod with a plate on the end will be used to determine water depth at the sample location in shallow water. If the depth of water dictates the use of an alternate measuring method, a sounding disc (secchi or similar) will be used.

6.3 Sediment Retrieval

All necessary sampling equipment and supplies listed in Section 6.0 and required personal protective equipment (PPE) should be loaded on the boat and the float plan communicated to the boat captain. After the sampling location has been reached, field personnel should ready the core sampling device. Sediment samples will be collected via core methods (e.g., Universal Core® sampler or equivalent check valve sampler) or a Petite Ponar or Ekman dredge sampling device. In water depths greater than 5 feet, additional aluminum extension rods or a slide hammer may be required for the coring equipment to achieve target depths.

6.3.1 Core Sampling

If using a Universal Core® sampler, the Lexan® sleeve will be attached securely to the core assembly. The field personnel should hand push or lightly drive with a hammer or fence-post driver, the core to the prescribed depth or to refusal. If refusal is encountered before the prescribed depth, personnel should adjust the sample location by off-setting the location by 2 feet. After reaching the prescribed depth (if using a check valve sampler) slowly lift the core out of the sediment and place a cap over the bottom of the tube to retain sediment. Set the core tube upright, remove the sampler, and allow the sediment to settle. Once settled, note the field length of the recovered core, and cut or drill into the tube using a hacksaw or drill to allow excess water to drain from the tube. Water should be drained back to its original source or disposed of following *SOP EN-106 - Investigative Derived Waste Management* if the water is obtained from the core when at the core processing location. After water has drained, cut the excess tube off, note any observations regarding oil and oil sheen on the surface of the sediment core, and place a cap over the top of the sediment core. Label the cap and the sleeve of the core with the sample location identification, date, and time collected. Place the core upright in a container (5-gallon bucket, cooler or similar) with ice for transportation.

During field sampling relevant notes will be recorded as per *SOP EN101-Field Records* and will include the following information:

- Sampling crew, and oversight personnel,
- Type of equipment used,
- Location ID,
- Depth of water at sample location,
- General description of sample location including nearby containment,
- Depth of core penetration into the sediment for core collection,
- Field recovered length of sediment in the core,
- GPS coordinates of sample location per *SOP EN-104 - Survey*,
- General observations regarding oil/sheen on the water surface present, prior to, and during core collection, and
- Photograph identification numbers.

Processing the sediment cores and collecting samples to be submitted for analysis may be performed on site or at the field laboratory.

Power sheers are used to cut open the core tube from top to bottom along both sides, while the core is secured in a horizontal position. The core is split, and field personnel identify sample intervals. Sample intervals will be chosen based on requirements of specific work plans. Samples for volatile organic compounds (VOCs) will be collected immediately. After VOCs samples have been collected, core logging will commence. General notes recorded for each core will include:

- Settled length of recovered core,
- Date and time of core collection,
- Date and time of sample collection, and
- Personnel involved with logging, sampling and scribing.

Additionally, the following details may be recorded for each sediment layer:

- Sediment color,
- Field determined sediment texture per the Unified Soil Classification System (ASTM D-2488-09a),
- Presence/absence of visible organic matter,
- Sedimentary structure (ex: bedding), if applicable,
- Plasticity,
- Cohesiveness,
- UV fluorescence,
- Photoionization Detector (PID) screening,
- Any other distinct features in the sediment core,
- Sheen description per SOP EN-204 -Static Sheen Testing, and
- Photograph identification numbers.

All information should be logged in the appropriate field documentation (field logbook, sampling form, and/or electronic data collector). Once analytical sample collection is complete all waste sediment and materials will be disposed of according to *SOP EN-106 - Investigative Derived Waste Management.*

6.3.2 Ponar or Ekman Dredge Sampling

After the sampling location has been reached, field personnel should ready the dredge sampling device by attaching a nylon rope, cable or pole to the top of the sampler. The sampler should then be placed in the "open" position. Slowly lower the sampler to just above the sediment surface and then drop the sampler quickly into the sediment to trigger the release mechanism, which should close the sampler. Raise the sampler to the water surface, inspect sample integrity, and carefully decant off surface water in the sampler through the screens. Open the sampler and transfer the contents to a stainless steel, Pyrex®, or disposable bowl. Samples for VOCs will be collected prior to homogenization. If additional sample volume is needed, repeat collecting sediment in the manner described above.

6.4 Sample Handling and Preservation

Samples to be analyzed for VOCs will be collected directly from the core or from the grab sample that has been deposited into a stainless steel bowl or similar prior to homogenization. Thoroughly homogenize (until visually uniform) the remaining sample interval after logging the core description. Fill the sample jars provided for the sampling location and appropriate analysis.

Once each sample container is filled, clean the rim and threads of the sample container by wiping with a paper towel.

Cap and label the container with (at a minimum) the sample identifier, sampling date and time, and sampler's initials. Additional information such as preservation information and analytical tests may also be added to the sample label as appropriate. Sample labeling will be conducted per the QAPP.

Place the sample containers into a cooler and maintain on ice. Complete sample chain of custody and other documentation per *SOP EN-102 Chain of Custody Procedures.* Package the samples for shipment to the laboratory per *SOP EN-103 Packaging and Shipment of Environmental Samples.*

6.5 Equipment Decontamination

All reusable equipment shall be decontaminated in accordance with *SOP EN-105 Decontamination of Field Equipment*. All investigation derived waste generated from the sampling effort (gloves, disposable sampling equipment, decontamination water, etc.) shall be appropriately containerized and transported to the onsite collection area for appropriate disposal per *SOP EN-106 Investigation Derived Waste Management.*

7.0 DATA AND RECORDS MANAGEMENT

The data associated with sediment sample collection may be contained in the following:

- Sample labels,
- Chain of custody records and custody seal(s),
- Field logbook,
- Sample collection records,
- Electronic data collection (Trimble Yuma® or equivalent),
- Field Modification Forms (used prior to field work, when required), and
- Nonconformance Records (used after field work, when required).

The following SOPs describe the data collection and record management procedures that should be followed as part of the sediment sample collection process:

- *SOP EN-101 Field Records,*
- *SOP EN-102 Chain of Custody Procedures,*
- *SOP EN-103 Packaging and Shipment of Environmental Samples,*
- *SOP EN-104 Survey,*
- *SOP EN-105 Decontamination of Field Equipment, and*
- *SOP EN-106 Investigative Derived Waste Management.*

See the referenced *SOPs* for additional details.

8.0 QUALITY ASSURANCE AND QUALITY CONTROL

Quality Control (QC) samples collected during sediment sample collection may include field duplicates, equipment and/or field blanks, trip blanks, and matrix spike/matrix spike duplicates (MS/MSD). See the QAPP for collection frequency and methods.

9.0 REFERENCES

Enbridge, 2011a. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Sampling and Analysis Plan (SAP). August 30, 2011.

Enbridge, 2011b. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Quality Assurance Project Plan (QAPP). August 19, 2011.

Enbridge, 2010. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Health and Safety Plan (HASP). August 2010.

ASTM-2488-09a Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).

Code of Federal Regulations, Chapter 40 (Section 261.4(d)).

SOP EN-101 –Field Records.

SOP EN-102– Chain of Custody Procedures.

SOP EN-103– Packaging and Shipment of Environmental Samples.

SOP EN-104– Survey.

SOP EN-105– Decontamination of Field Equipment.

SOP EN-106 – Investigation Derived Waste Management.

SOP EN-204—Sheen Jar Test

U.S. EPA. 1998. EPA's Contaminated Sediment Management Strategy. U.S. Environmental Protection Agency, Office of Water, Washington, DC. EPA 823/R-98/001.

U.S. EPA. 2001. Methods for Collection, Storage, and Manipulation of Sediments for Chemical and Toxicological Analyses: Technical Manual. Office of Water EPA-823-B-01-002 October 2001.

U.S. EPA. 2005. Contaminated Sediment Remediation Guidance for Hazardous Waste Sites USEPA, Office of Solid Waste and Emergency Response, EPA-540/R-05/012, 236 pp, 2005.

Approved

Enbridge Line 6B MP 608

Marshall, MI Pipeline Release

Procedures for Thin Sheen Oil Sample Collection – SOP EN-203

Prepared for Michigan Department of Environmental Quality

Enbridge Energy, Limited Partnership

Approved: August 30, 2011

Approved

Approved

LIST OF ACRONYMS

GPS	Global Positioning Satellite
HASP	Health and Safety Plan
IDW	Investigative Derived Waste
OSHA	Occupational Safety and Health Administration
oz	Ounce
PID	Photoionization detector
PPE	Personal Protective Equipment
QAPP	Quality Assurance Project Plan
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedure
TFE	tetrafluoroethylene

Approved

1.0 SCOPE AND METHOD SUMMARY

This Standard Operating Procedure (SOP) defines the procedures to be used for sampling thin oil films or sheens using tetrafluoroethylene (TFE)-fluorocarbon polymer sampling nets. The specific details of actual sample collection are dependent upon local conditions as well as the purpose of the sampling.

It is expected that the procedures outlined in this SOP will be followed. Procedural modifications may be warranted depending on field conditions, equipment limitations, or limitations imposed by the procedure. Substantive modification to this SOP will be noted in task-specific work plans or on Field Modification Forms as appropriate and will be approved in advance by the Task Manager. Deviations from the SOP will be documented in the project records and in subsequent reports.

The procedure is designed to collect the oil sheen sample with a minimum of water, thereby reducing the possibility of chemical, physical, or biological alteration by prolonged contact with water between the time of collection and analysis. The procedure was developed following methods outlined in *ASTM D4489 (2006) and Plourde* and *others (1995)*. Use of TFE-fluorocarbon polymer sampling nets collect approximately ten times the quantity of oil as compared to the traditional decanting method in thin sheen oil release applications. The nets also collect biogenic material in addition to petroleum oils, and therefore can be used for the collection of both biological and oil based sheens.

2.0 PERSONNEL QUALIFICATIONS

Thin sheen sample collection is a relatively involved procedure requiring training. It is recommended that initial sampling be supervised by more experienced personnel.

Field personnel must be health and safety certified as specified by the *Occupational Safety and Health Administration (OSHA) (29 CFR 1910.120(e)(3)(i))* to work on sites where hazardous materials may be present.

It is the responsibility of the field personnel to be familiar with the sampling procedures outlined within this SOP, with specific analytical sampling procedures, quality assurance, and health and safety requirements outlined within this *Sampling and Analysis Plan (SAP)* (Enbridge, 2011a), the *Quality Assurance Project Plan (QAPP)* (Enbridge, 2011b), the *Health and Safety Plan (HASP)* (Enbridge, 2010) and work plans under which the sampling will be conducted. Field personnel are responsible for sample collection, decontamination of equipment, and proper documentation in the field logbook, field forms, or electronic data collector such as the Trimble Yuma® or equivalent (as appropriate).

3.0 HEALTH AND SAFETY

The health and safety considerations for the work associated with this SOP, including both potential physical and chemical hazards, will be addressed in the site specific HASP. All work will be conducted in accordance with the HASP.

Contact with oil should be minimized, even when wearing the appropriate personal protective equipment (PPE).

4.0 INTERFERENCES

When handling the TFE-fluorocarbon polymer sampling nets, nitrile gloves should be worn at all times to avoid contaminating the nets with finger oils.

Once collected, TFE-fluorocarbon polymer sampling net samples should be stored in a sample cooler or refrigerator at a temperature of 4° to 5° C. Storage above this temperature range can lead to biological degradation and storage below this temperature range can lead to irreversible crystallization of waxes.

Some oil does not spread out in a homogeneous sheen, the oil pools in thicker pockets on the water, making collection of sample representative of the entire slick difficult. In these instances, detailed field notes and photographs of the sample area should be taken.

5.0 EQUIPMENT AND SUPPLIES

5.1 Required Equipment

The following equipment and materials are required:

- 4 inchdiameter/6 inchdeep 150 micron mesh TFE-fluorocarbon polymer nets with detachable support ring and handle, (General Oceanics, Inc. Part Number 5080-250 or equivalent product),
- 4 ounce (oz) glass jars and labels,
- Nitrile gloves,
- Appropriate PPE, as described in the site-specific HASP,
- Photoionization detector (PID) calibrated according to SOP EN-503 and as specified in the HASP,
- Field Logbook and/or sample collection forms,
- Pen with indelible ink,
- Paper towels,
- Cooler and ice for sample preservation, and
- Appropriate equipment and supplies for equipment decontamination (Refer to SOP EN-105).

5.2 Optional Equipment

The following equipment is optional:

- Camera,
- Access to a boat (if required),
- Nautical equipment (anchors, lines, personal flotation devices, etc.) (if required),
- 3 to 8 foot long telescopic pole (General Oceanics, Inc. Part Number 2030WN or equivalent product) , and
- Global positioning satellite (GPS) receiver and data logger.

6.0 METHODS

1. Select the sampling location and document in the field logbook and/or sample collection form. If possible, obtain PID readings of the air above the sheen and record. If necessary, photograph the location and/or record the location with the GPS receiver.
2. Don the appropriate PPE and a fresh pair of nitrile gloves.
3. Remove the TFE-fluorocarbon polymer net from the sealed plastic bag making sure to only touch the plastic handle of the support ring. If using the telescopic pole, attach the handle of the supporting plastic ring to the telescopic pole. Do not allow the net to come in contact with anything.
4. Take the sample by skimming the net through the sheen and straining the oily water through the net. Make sure the sheen is entering through the mouth of the net and straining through the fine mesh of the net. Slowly skim the sheen surface with the net back and forth through the full length of the sheen, or the largest possible area of the sheen, at least eight times.
5. Once skimming is complete, unclip the support ring and remove the TFE-fluorocarbon polymer net and place the net into the clean 4-oz glass jar, making sure to touch the net as little as possible. Some water adhered to the net may settle in the bottom of the jar.
6. Don a fresh pair of gloves and place the lid on the 4-oz glass jar. Wipe down any oil that may have adhered to the outside of the jar and lid with paper towels.
7. Immediately label the sample jar containing the TFE-fluorocarbon polymer net and place in a sample cooler with ice.
8. Discard the plastic support ring and handle according to the Investigative Derived Waste (IDW) procedures in the work plan.
9. If the telescopic pole was used, decontaminate the end of the pole or any part of the pole that came in contact with the oil according to the procedures in SOP EN-105.

7.0 DATA RECORDS & MANAGEMENT

The data associated with thin sheen oil sample collection is contained within the following:

- Sample labels;
- Chain of custody records and custody seal(s);
- Field logbook;
- Sample collection records;
- Electronic data collection (Trimble Yuma® or equivalent);
- Field Modification Forms (used prior to field work, when required); and
- Nonconformance Records (used after field work, when required).

The following SOPs describe the data collection and record management procedures that should be followed as part of the sample collection process:

- *SOP EN-101 Field Records,*
- *SOP EN-102 Chain of Custody Procedures, and*
- *SOP EN-103 Packaging and Shipment of Environmental Samples.*

8.0 QUALITY ASSURANCE / QUALITY CONTROL

If a new release is suspected, it is recommended that multiple samples be taken of waterborne oil in order to demonstrate the homogeneity of the release. The samples should be taken in different regions of the sheen or slick at points where the accumulation is the heaviest. If multiple samples cannot be collected, a single sample should be collected from the area where the accumulation of oil visually appears to be the heaviest.

9.0 REFERENCES

Enbridge, 2011a. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Sampling and Analysis Plan (SAP). August 30, 2011.

Enbridge, 2011b. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Quality Assurance Project Plan (QAPP). August 19, 2011.

Enbridge, 2010. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Health and Safety Plan (HASP). August 2010.

American Society for Testing and Materials. 2006. Standard Practices for Sampling of Waterborne Oils. ASTM D4489. ASTM Committee D19 on Water. December 2006.

Plourde, et al.1995. Nets: A Novel Approach to Thin Sheen Oil Sampling. U.S. Coast Guard Marine Safety Laboratories. Groton, CT. 1995.

SOP EN-101 – Field Records

SOP EN-102 – Chain of Custody Procedures

SOP EN-103 – Packaging and Shipment of Environmental Samples

United States Environmental Protection Agency. 2001. Guidance for Preparing Standard Operating Procedures (SOPs). EPA QA/G-6. EPA/240/B-01/004. USEPA Office of Environmental Information, Washington, DC. March 2001.

Approved

Enbridge Line 6B MP 608

Marshall, MI Pipeline Release

Static Sheen Testing – SOP EN-204

Prepared for Michigan Department of Environmental Quality

Enbridge Energy, Limited Partnership

Approved: August 30, 2011

Approved

LIST OF ACRONYMS

gm	gram
HASP	Health and Safety Plan
MDEQ	Michigan Department of Environmental Quality
MS/MSD	Matrix Spike/Matrix Spike Duplicate
OSHA	Occupations Safety and Health Administration
QAPP	Quality Assurance Project Plan
QC	Quality Control
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedure
U.S. EPA	United States Environmental Protection Agency
UV	ultraviolet

Approved

1.0 SCOPE AND METHOD SUMMARY

This Standard Operating Procedure (SOP) describes the basic techniques and general considerations to be followed for static sheen testing of sediment samples to determine if free oil is contained within the sample. For the purposes of this SOP, sediment is defined as soil, sand, silt, clay, organic matter, or other materials that accumulate on the bottom of a water body *(United States Environmental Protection Agency (U.S. EPA) 1998, 2001, and 2005).* Free oil refers to any oil contained within sediment or soil that is present as a nonaqueous phase liquid

It is expected that the procedures outlined in this SOP will be followed. Procedural modifications may be warranted depending on equipment limitations or limitations imposed by the procedure. Substantive modification to this SOP will be noted in task-specific work plans or on Field Modification Forms as appropriate and will be approved in advance by the Task Manager. Deviations from the SOP will be documented in the project records and in subsequent reports.

The static sheen test generally involves dispersing a sediment sample in a container of test water and observing if the sample causes a sheen, iridescence, gloss, or increased reflectance on the surface of the test water *(U.S. EPA, 2005)*. Observations will be recorded in a field notebook or field log.

2.0 PERSONNEL QUALIFICATIONS

Field personnel must be health and safety certified as specified by the *Occupational Safety and Health Administration (OSHA) (29 CFR 1910.120(e)(3)(i))* to work on sites where hazardous materials may be present.

It is the responsibility of the field personnel to be familiar with the sheen testing procedures outlined within this SOP, with health and safety requirements outlined within this *Sampling and Analysis Plan (SAP) (Enbridge, 2011a),* the *Health and Safety Plan (HASP) (Enbridge, 2010)* and work plans under which the sampling/testing will be conducted. Field personnel are responsible for static sheen testing of samples, decontamination of equipment, disposal of waste, and proper documentation in the field logbook, electronic data collector and/or field forms.

3.0 HEALTH AND SAFETY

The health and safety considerations for the work associated with this SOP, including both potential physical and chemical hazards, is addressed in the site specific HASP. All work will be conducted in accordance with the HASP.

Static sheen testing may involve physical and/or chemical hazards associated with exposure to water, sediment, or materials in contact with either water or sediment. When sediment sampling is performed, adequate health and safety measures must be taken to protect field personnel. These measures are addressed in the project HASP.

4.0 INTERFERENCES

Potential interferences could result from cross-contamination from residual free oil adhering to sampling containers. Minimization of the cross-contamination will occur through the use of clean, decontaminated or dedicated sampling tools for each test.

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5.0 EQUIPMENT AND SUPPLIES

The following equipment list contains materials that may be needed to carry out the procedures contained in this SOP:

- Test containers from laboratory pre-filled with distilled deionized water,
- Weighing boats,
- Stainless steel spatula,
- UV Fluorescent light source
- Electronic or triple-beam scale,
- Meter for measuring water temperature,
- Equipment decontamination supplies,
- Health and safety supplies (as required by the HASP),
- Waterproof marker pens (Sharpie® or similar),
- Sediment core or soil boring field log, field logbook, electronic data collector, or field form, and
- Camera.

6.0 METHODS

The method in this SOP is an adaptation of the *U.S EPA Static Sheen Test (Code of Federal Regulations, Title 40, Chapter 1, Part 435)* with some modification to water source and temperature to accommodate soil boring/sediment core processing in a laboratory facility. Test water will be distilled deionized water provided by the laboratory in prefilled jars rather than ambient receiving water (e.g. Talmadge Creek or Kalamazoo River). The temperature of the test water will be the room temperature of the observation facility. Samples collected during the winter months will be allowed to warm to room temperature prior to conducting the test. The surface of the water should be no more than 0.5 inches below the top of the test container.

In accordance with the U.S. EPA test method, fifteen gram (gm) samples of soil or sediment should be weighed on weighing boats using a scale. Samples will then be transferred to the test water by scraping the sediment or soil into the water with a disposable spatula. Soil or sediment shall not be prediluted prior to testing. The sediment or soil must be agitated to an even distribution of solids on the bottom of the test container.

Observations must be made no sooner than 5 minutes and no later than 1 hour after the sample material is transferred to the test container. Viewing points above the test container should be made from at least three sides of the test container, at viewing angles of approximately 60 and 30 degrees from the horizontal. Photographs taken to documentation the test results should also be taken from these approximate angles. Illumination of the test container must be representative of adequate lighting for a working environment to conduct routine laboratory procedures. It is recommended that the water surface of the test container be observed under a fluorescent light. Natural light may also be used. Ultra-violet (UV) may also be used as a secondary light source.

Detection of a silvery or metallic sheen or gloss, increased reflectivity, visual color, iridescence, or an oil film on the water surface of the test container surface shall constitute a demonstration of oil. These visual observations include patches, streaks, or sheets of such altered surface characteristics. If the oil content of the sample approaches 10%, the water surface of the test container may lack color, a sheen, or iridescence, due to the increased thickness of the film; but the thick film is indicative of the presence of oil.

During testing relevant notes will be recorded as per *SOP EN-101 (Field Records)* and will include the following information:

- Testing personnel,
- Type of equipment used,
- Location ID,
- General observations regarding oil/sheen on the water surface present, prior to, and during static sheen test,
- Approximate percent coverage of oil, sheen, or gloss on surface of water (ex: 5%, 25%, etc.),
- Color (ex: rainbow, silver, metallic, black, etc), and
- Photograph identification numbers.

All information should be logged in the appropriate field documentation (field logbook and/or sampling form).

6.1 Equipment Decontamination

All reusable equipment shall be decontaminated in accordance with *SOP EN-105 - Decontamination of Field Equipment*. All investigation derived waste generated from the sampling effort (gloves, disposable sampling equipment, decontamination water, etc.) shall be appropriately containerized and transported to the onsite collection area for appropriate disposal per SOP EN-106 - Investigative Derived Waste Management.

7.0 DATA AND RECORDS MANAGEMENT

The data associated with static sheen testing will be contained within the following:

- Field logbook,
- Electronic data collection (Trimble Yuma® or equivalent),
- Field Modification Forms (used prior to field work, when required), and
- Nonconformance Records (used after field work, when required).

The following SOPs describe the data collection and record management procedures that should be followed as part of the static sheen testing process:

- *SOP EN-101 Field Records,*
- *SOP EN-105 Decontamination of Field Equipment, and*
- *SOP EN-106 Investigative Derived Waste Management.*

8.0 QUALITY ASSURANCE AND QUALITY CONTROL

Quality Control (QC) samples may include field duplicates, equipment and/or field blanks, trip blanks, and matrix spike/matrix spike duplicates (MS/MSD). See the *Quality Assurance Project Plan (QAPP)* (Enbridge, 2011b) for collection frequency and methods.

9.0 REFERENCES

Enbridge, 2011a. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Sampling and Analysis Plan (SAP). August 30, 2011.

Enbridge, 2011b. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Quality Assurance Project Plan (QAPP). August 19, 2011.

Enbridge, 2010. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Health and Safety Plan (HASP). August 2010.

ASTM-2488-09a Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).

Code of Federal Regulations, Chapter 40 (Section 261.4(d)).

Code of Federal Regulations, Title 40, Chapter 1, Part 435

SOP EN-101 –Field Records.

SOP EN-105– Decontamination of Field Equipment.

SOP EN-106 – Investigation Derived Waste Management.

U.S. EPA. 1998. EPA's Contaminated Sediment Management Strategy. U.S. Environmental Protection Agency, Office of Water, Washington, DC. EPA 823/R-98/001.

U.S. EPA. 2001. Methods for Collection, Storage, and Manipulation of Sediments for Chemical and Toxicological Analyses: Technical Manual. Office of Water EPA-823-B-01-002 October 2001.

U.S. EPA. 2005a. Contaminated Sediment Remediation Guidance for Hazardous Waste Sites USEPA, Office of Solid Waste and Emergency Response, EPA-540/R-05/012, 236 pp, 2005.

Approved

Enbridge Line 6B MP 608

Marshall, MI Pipeline Release

Subsurface Soil Sampling by Geoprobe® Methods – SOP EN-301

Prepared for Michigan Department of Environmental Quality

Enbridge Energy, Limited Partnership

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Approved

TABLE

FIGURES

Approved

LIST OF ACRONYMS

HASP	Health and Safety Plan
MDEQ	Michigan Department of Environmental Quality
OSHA	Occupational Safety and Health Administration
PETG	Polyethylene Terephthalate Glycol
PVC	Polyvinyl Chloride
QAPP	Quality Assurance Project Plan
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedure
VOC	Volatile Organic Compound

1.0 SCOPE & METHOD SUMMARY

1.1 Purpose and Applicability

This Standard Operating Procedure (SOP) describes the basic techniques and general considerations to be followed for the collection of subsurface soil samples using commercially available Geoprobe Systems® (or equivalent) direct-push soil probing equipment. Subsurface soil samples may be obtained using this system for purposes of determining subsurface soil conditions and for obtaining soil samples for physical and/or chemical evaluation.

The purpose of this SOP is to provide a description of a specific method or procedure to be used in the collection of subsurface soil samples using the Geoprobe System®. Subsurface soil is defined as unconsolidated material which may consist of one or a mixture of the following materials: sand, gravel, silt, clay, peat (or other organic soils), and fill material. Subsurface soil sampling, conducted in accordance with this SOP will promote consistency in sampling and provide a basis for sample representativeness.

This SOP covers subsurface soil sampling using Geoprobe Systems® equipment (or equivalent); specifically, the Dual Tube Sampling Systems, the Macro-Core® Soil Sampler, and the Large Bore Sampler. Use of this sampling equipment requires use of the Geoprobe® hydraulically-powered percussion/probing machine or equivalent. Geoprobe® sampling is usually performed by subcontractors, although rental equipment is available for use by trained operators.

The Geoprobe® sampling methods covered in this SOP are applicable to unconsolidated soil/fill materials. Sampling depths are greatly dependent upon soil density as the hydraulically-powered probing unit has power limitations. Sample recovery is also somewhat dependent on grain size as very coarse gravel, cobbles, and boulders will occasionally cause premature refusal of the sample tooling. It is generally preferable to have some prior knowledge of site soil conditions if sampling activities are proposed where equipment limitations may become a factor.

It is expected that the procedures outlined in this SOP will be followed. Procedural modifications may be warranted depending on field conditions, equipment limitations, or limitations imposed by the procedure. Substantive modification to this SOP will be noted in task-specific *work plans* or on *Field Modification Forms* as appropriate and will be approved in advance by the Task Manager. Deviations from the SOP will be documented in the project records and in subsequent reports.

1.2 General Principles

Soil sampling using the Geoprobe System® requires use of the hydraulically-powered percussion/probing machine and one of the Dual Tube Sampling Systems (DT22 or DT 325), the Macro-Core® Soil Sampler or the Large Bore Sampler soil sampling devices. The percussion/probing machine is typically mounted on a tracked or truck chassis. The percussion/probing machine, through its hydraulic operation, pushes and hammers the soil sampling equipment vertically into the ground. The soil sampler is then extracted from the ground to recover the sample.

The Dual Tube Sampling Systems (*Figure 1*) use two sets of probe rods to collect a continuous soil core; an outer rod and an inner rod containing a polyvinyl chloride (PVC) liner. The outer set of probe rods are directly driven by the percussion/probing machine and act as an outer casing preventing borehole collapse and providing a sealed borehole from which continuous soil samples can be collected. The smaller inner probe rods hold the sampler liner in place as the outer probe rods are driven into the ground. The inner rods are then removed from within the outer rods to retrieve the filled sample liner. Once the inner rods and attached sample liner are removed from the outer casing, the plastic liner containing the soil sample is removed from the tool. The liner is then cut, exposing the soil to be evaluated. This sampling tool is most often used for soil profiling and collection of larger volume soil samples.

Macro-Core® Sampler (*Figure 2*) consists of a 1.5-inch diameter open-ended steel sampling tool with liners made of clear plastic (Polyethylene Terephthalate Glycol (PETG) or PVC), stainless steel, or Teflon®. This sampler is designed for discrete interval sampling and is not affected significantly by borehole wall collapse. This sampler is similar to a piston sampler where a retractable drive (piston) point is withdrawn when the targeted sampling interval is achieved and the soil sample enters the sampler. The tool can also be used in a continuous sampling capacity in an open borehole up to depths of approximately 30 feet. Once the sampling tool is removed from the ground, the plastic liner containing the soil sample is removed from the tool. The liner is then cut, exposing the soil to be evaluated. This sampling tool is most often used for soil profiling and collection of larger volume soil samples.

The Large Bore Sampler (*Figure 3*) consists of a 22-inch long by a slightly over 1-inch diameter steel sampling tool and may be used for sampling to depths up to approximately 30 feet. Various liner types are available for use with this sampler, and include: plastic, brass, stainless steel, and Teflon®. The metal liners are available in segmented 6-inch lengths. This sampler is designed for discrete interval sampling and is not affected significantly by borehole wall collapse. This sampler is similar to a piston sampler where a retractable drive (piston) point is withdrawn when the targeted sampling interval is achieved and the soil sample enters the sampler. Once the sampler is removed from the ground, the inserted liner containing the soil sample is extracted from the sampler and the soil sample is then cut from or extracted from the liner. The segmented liner materials and discrete interval sampling capability gives this device greater suitability for collection of smaller volume soil samples.

2.0 PERSONNEL QUALIFICATIONS

2.1 Field Staff

It is the responsibility of the field staff to conduct subsurface soil sampling in a manner which is consistent with this SOP. Field staff will observe all activities pertaining to subsurface soil sampling to ensure that the SOP is followed, and to record all pertinent data into a digital capture device, onto a boring log or into field logbook. It is also the responsibility of field staff to indicate the specific targeted sampling depth or sampling interval to the drilling subcontractor. Field staff will also collect representative environmental or stratigraphic characterization samples once the sampling device has been retrieved and opened. Additional sample collection responsibilities include labeling, handling, and storage of samples until further chain of custody procedures are implemented.

Field personnel must be health and safety certified as specified by the *Occupational Safety and Health Administration (OSHA) (29 CFR 1910.120(e)(3)(i))* to work on sites where hazardous waste materials may be present.

2.2 Drilling Subcontractor

It is the responsibility of the drilling subcontractor to provide the necessary Geoprobe® equipment for obtaining subsurface soil samples. This generally includes the truck- or all terrain vehicle-mounted percussion/probing machine and the Dual Tube System or one or more Macro-Core® and Large Bore samplers in good operating condition, appropriate liners, and other necessary equipment for borehole preparation and sampling. Equipment decontamination materials should also be provided by the subcontractor and decontamination should follow *SOP EN-0105 – Decontamination of Field Equipment*.

Drilling personnel must be health and safety certified as specified by OSHA to work on sites where hazardous waste materials may be present.

3.0 HEALTH AND SAFETY

The health and safety considerations for the work associated with this SOP, including both potential physical and chemical hazards, is addressed in the site specific *Health and Safety Plan (HASP)* (Enbridge, 2010). All work will be conducted in accordance with the HASP.

Boring completion may involve physical and/or chemical hazards associated with exposure to soil, water, sediment, or materials in contact with soil, water, or sediment. When Geoprobe® sampling is performed, adequate health and safety measures must be taken to protect field personnel. These measures are addressed in the project HASP

4.0 INTERFERENCES

Potential interferences could result from cross-contamination between borehole locations. Minimization of the cross-contamination will occur through the use of clean sampling tools at each location, which will require decontamination of sampling equipment as per *SOP EN-105 – Decontamination of Field Equipment.*

5.0 EQUIPMENT & SUPPLIES

In addition to those materials provided by the subcontractor, the following equipment list contains materials which may be needed in carrying out the procedures contained in this SOP. Not all equipment listed below may be necessary for a specific activity. Additional equipment may be required, pending field conditions.

- Boring logs or electronic data collection (such as Trimble Yuma® or equivalent),
- Teaspoon, spatula, or equivalent,
- Analytical Sample kit (bottles, labels, preservatives, custody records, tape, cooler, and ice),
- Sample collection pan (if collecting a composite sample),
- Folding rule or tape measure,
- Equipment decontamination materials (as required by *SOP EN-105*),
- Health and safety equipment (as required by the HASP), and
- Field project notebook and pen.

Sampling equipment which comes in direct contact with environmental samples during the sample collection process should be constructed of stainless-steel, Teflon®, or glass, unless specified otherwise in a work plan or *Quality Assurance Project Plan (QAPP)* (Enbridge, 2011).

Other materials that may be required:

- Liner cutter,
- Camera,
- Color chart,
- Gloves,
- Potable water supply,
- Plastic sheeting,
- Trash bags, and
- Paper towels.

Appropriate containers and materials to manage investigation derived waste (as specified in the Work Plan and as required by *SOP EN-106 – Investigative Derived Waste Management*.

6.0 METHODS

6.1 General Method Description

Geoprobe® soil sampling methods generally involve collection of soil samples by driving the sampling tool directly into the ground using the percussion/probing machine and without the aid of hollow-stem augers or other casing-installed drilling methods. The Dual Tube Sampling Systems, Macro-Core® , and Large Bore soil samplers consist of metal tubes of seamless construction which cannot be split apart like split-spoons. Liner/sleeve inserts are used to extract an intact soil core/sample from the sampling device.

These sampling devices operate by being directly pushed and/or hammered into the ground by the percussion/probing machine. The borehole is created as the sampling device is advanced downward. The Dual Tube Sampling Systems collect a continuous soil core utilizing an outer rod and an inner rod with a PVC (or other) liner. The outer set of probe rods are directly driven by the percussion/probing machine and act as an outer casing preventing bore hole collapse and providing a sealed borehole from which continuous soil samples can be collected. The smaller inner probe rods hold the sampler liner in place as the outer probe rods are driven into the ground. The inner rods are then removed from within the outer rods to retrieve the filled sample liner. Once the inner rods and attached sample liner are removed from the outer casing, the plastic liner containing the soil sample is removed from the tool. The liner is then cut, exposing the soil to be evaluated by the field staff.

The Macro-Core® Sampler can collect samples either continuously requiring an open borehole be maintained for efficient sample recovery or as a discrete sampler. The Large Bore Sampler contains a piston tip/drive point which allows for advancing the sampler to a designated depth for discrete interval sampling. The piston tip is retracted when the desired sampling interval is reached. When the soil sampling device is retrieved from the borehole, the drive head, cutting shoe and/or piston assembly is removed, and the liner insert with sample is removed from the sampling device. Field staff is then given access to the sample for whatever purpose is required.

Table 1 summarizes the construction characteristics and sampling attributes of each type of sampler. The appropriate type of sampler should be selected based on project-specific sampling requirements.

6.2 Equipment Decontamination

Each sampling device must be decontaminated prior to its initial use and following collection of each soil sample, especially if sampling for analytical testing purposes is conducted. If sampling for soil logging only is conducted, thorough sampler decontamination between samples may not be necessary although sufficient cleansing is necessary for the sampler to operate properly. Site-specific requirements for equipment decontamination are outlined in the *SOP EN-105 - Decontamination of Field Equipment*.

6.3 Sampling Procedure – Dual Tube Sampling System

6.3.1 Sample Tooling

- Decontaminate the sampler parts (cutting shoe, inner and outer probe rods, and drive tips) before assembly.
- Assemble the outer probe rod with a cutting shoe. Tighten the cutting shoe with the shoe wrench or pipe wrench.
- Assemble the inner sampler by first placing a catch basket on one end of the PVC liner. Then place the drive head on the opposing end of the PVC liner. Insert the liner/drive head assembly into the outer probe rod such that the core catcher contacts the cutting shoe.
- Install the threadless drive cap onto the outer probe rod.
- Place entire assembly under the percussion/probing machine for driving.

6.3.2 Sampling

- Using the percussion/probing machine, drive the sampler completely into the ground until the drive head reaches the ground surface.
- Use the machine hydraulics to pull the inner rod(s) and sample liner from the outer probe rod.
- Repeat, adding another liner/drive head assembly and additional inner and outer probe rods to the drill string and proceed to collect continuous soil core until the targeted end-of-boring is reached.
- Once end-of-boring is attained, use the machine hydraulics to pull the outer probe rods before or during borehole abandonment.

6.3.3 Sample Recovery

- Use the machine hydraulics to pull the inner rod(s) and sample liner from the outer probe rod.
- Once the inner probe rods and liner/drive head assembly has been removed from the outer probe rods, the liner must be removed from the drive head.
- Disconnect the drive head from the liner which contains the soil sample. The recovered soil sample may now be viewed, logged, and extracted from the liner for analysis.

6.4 Sampling Procedure - Macro-Core® Sampler

6.4.1 Sample Tooling

- Decontaminate the sampler parts (cutting shoe, sample tube, liners (plastic liners are disposable and do not require decontamination)) before assembly.
- Assemble the sampler by first placing the catch basket in the end of the liner. Then place the basket and liner over the inside end of the cutting shoe, then inserting the liner/shoe assembly into the sample tube, and then finally threading the cutting shoe into the sample tube. Tighten the cutting shoe with the shoe wrench or pipe wrench.
- Thread the sampler onto the drive head.

6.4.2 Sampling

- Using the percussion/probing machine, drive the sampler completely into the ground until the drive head reaches the ground surface.
- Use the machine hydraulics to pull the sampler from the borehole.
- Repeat, advancing the sampler to the prior depth, adding a length of drilling rod.
- For sampling where subsurface conditions result in borehole collapse or sampling starts below ground surface, the sampler can be assembled as a discrete sampler with the addition of a piston rod, piston tip, and stop pin. Drive the sampler into the ground until the upper portion of the targeted sampling interval is achieved. Unthread and remove the stop-pin from the drive head using extension rods. This will activate the piston tip/rod.
- Drive the sampler through the targeted sampling interval to collect the sample. The piston tip/rod will retract as the sample enters the sample tube.
- Use the machine hydraulics to pull the sampler from the borehole.

6.4.3 Sample Recovery

- Once the sampler has been removed from the borehole, the sampler must be unthreaded from the drive head, the cutting shoe unthreaded from the sampler, and the liner/shoe assembly removed from the sample tube.
- Disconnect the cutting shoe from the liner which contains the soil sample. The recovered soil sample may now be viewed, logged, and extracted from the liner for analysis.

6.5 Sampling Procedure – Large Bore Sampler

6.5.1 Sampler Preparation

- Decontaminate the sampler parts (cutting shoe, piston rod/tip, sample tube, liners) before assembly.
- Assemble the sampler by first placing the catch basket and liner on the cutting shoe, then threading the liner/shoe assembly into the sample tube, then connecting the piston tip to the piston rod, and then finally inserting the piston tip/rod assembly into the sample tube. Tighten the cutting shoe with the shoe wrench.
- Thread the sampler onto the drive head. Thread the stop-pin onto the drive head (stop-pin holds the piston tip/rod in place while driving the sampler to the desired sample interval).

6.5.2 Sampling

- Using the percussion/probing machine, drive the sampler into the ground until the upper portion of the targeted sampling interval is achieved.
- Unthread and remove the stop-pin from the drive head using extension rods. This will activate the piston tip/rod.
- Drive the sampler through the targeted sampling interval to collect the sample. The piston tip/rod will retract as the sample enters the sample tube.
- Use the machine hydraulics to pull the sampler from the ground.

6.5.3 Sample Recovery

- Once the sampler has been removed from the ground, the sampler must be unthreaded from the drive head, then the cutting shoe unthreaded from the sample tube, and the liner/shoe assembly removed from the sample tube.

- Disconnect the cutting shoe from the liner which contains the soil sample. The recovered soil sample may now be viewed, logged, and extracted from the liner for analysis.

6.6 Sample Containment

- The soil sample can be removed from the liner following viewing and/or logging. Non-segmented plastic or Teflon® liners should be cut in half with a retractable blade or other safe utensil to facilitate sample extraction or to isolate specific sample zones targeted for analysis. Segmented metal liners can be manually separated.
- The individual halves of the liners can then be screened with UV light and fluorescence is noted on the boring log.
- Once the soil has been screened with UV light, the soil sample is inspected and a soil boring log can then be completed describing the soil type, color, visible oil, cohesiveness, moisture, plasticity, drive and recovery depths.
- The soil sample may then be extracted from the individual liner segments with a spoon or spatula. Then the sample should be placed directly into the required sample container.
- Once filled, the sample container should be properly capped, cleaned and labeled and recorded in the field book. Sample chain of custody and preservation procedures should then be initiated.
- If using disposable equipment, perform equipment decontamination following collection of the sample.

6.7 Sampling for Volatile Organic Compounds

- Create a clean workspace using clean polyethylene sheeting.
- Put on clean gloves immediately before sampling.
- Decontaminate the field scale and calibrate it with the 10-gram weight provided. Use the scale and weigh an empty syringe. Write the weight of the empty syringe in your field notebook. Open the Geoprobe® liner with an approved cutting tool, and insert the open end of the syringe into a fresh face of undisturbed soil (if possible). The VOC sample may be collected from the sample location by inserting the plastic syringe tool directly into the soil

- Push the syringe into the soil and fill it to the point where you believe that you have 10 grams of soil (you may wish to practice filling and weighing the syringe with similar soil from the same sampling location prior to taking your actual sample in order to get an idea of how much soil is required for a 10-gram sample).
- Using your gloved index finger, thumb, or other instrument, push the soil deeper into the syringe. Note that any material (gloves, instruments, etc.) touching the sample must be decontaminated and clean. Attempt to obtain an area at the opening of the syringe clear of soil. This will assist you in minimizing the amount of contaminants that will adhere to the scale.
- Weigh the soil-filled syringe with the field scale and write the weight in your field notebook.
- Subtract the weight of the syringe from the total weight of syringe and soil (soil must weigh 10 grams +/- 1 gram tolerance for a 9- to 11-gram range, WITHOUT the weight of the syringe). If you do not have 10 +/- 1 grams of soil, you MUST repeat steps 4 through 6, above, until you have a total of 10 +/- 1 grams of soil. For most soils, the same volume of soil will yield approximately the same weight of soil. If you have too much soil, you must remove the excess soil from the syringe until you fall within the 9- to 11-gram range.
- Write the soil weight in your field notebook. You do not need to provide the weight of the sample to the Laboratory; they will reweigh the sample upon receipt.
- Remove the cap from the 40-ml vial.
- Insert the open end of the syringe into the vial, push the plunger, and discharge the soil.
- Place cap TIGHTLY on the 40-ml vial and gently shake it for ten seconds.
- Completely fill out the sample label on the 40-ml vial.

7.0 DATA & RECORDS MANAGEMENT

The data associated with subsurface soil sampling by Geoprobe® methods will be contained in the following:

- Boring logs (example shown as *Figure 4* or equivalent),
  - Field screen results/observations and sample collection locations/intervals will be included on the Boring Log.
  - Driven depth and recovered depth will also be recorded.
- Sample collection records,
- Field logbook,
- Chain of custody records,
- Shipping labels,
- Electronic data collection (Trimble Yuma® or equivalent),
- Field Modification Forms (used prior to field work, when required), and
- Nonconformance Records (used after field work, when required).

The following SOPs describe the data collection and record management procedures that should be followed as part of the sample collection process:

- *SOP EN-101 Field Records,*
- *SOP EN-102 Chain of Custody Procedures,*
- *SOP EN-103 Packaging and Shipment of Environmental Samples, and*
- *SOP EN-503 Photoionization Detector Measurement*.

See the referenced SOPs for additional details.

8.0 QUALITY ASSURANCE AND QUALITY CONTROL

Quality Control (QC) samples collected via subsurface soil sampling may include field duplicates, equipment and/or field blanks, trip blanks, and *matrix spike/matrix spike duplicates (MS/MSD)*. See the QAPP for collection frequency and methods.

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9.0 REFERENCES

Enbridge, 2010. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Health and Safety Plan (HASP). August 2010.

Enbridge, 2011. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Quality Assurance Project Plan (QAPP). August 19, 2011.

Geoprobe Systems®, January 2011. Geoprobe® DT325 Dual Tube Sampling System, Standard Operating Procedure. Technical Bulletin No. MK3138.

Geoprobe Systems®, January 2011. Geoprobe® Macro-Core® MC5 1.25-inch Light-Weight Center Rod Soil Sampling System, Standard Operating Procedure. Technical Bulletin No. MK3139.

Geoprobe Systems®, January 2011. Geoprobe® DT22 Dual Tube Sampling System, Standard Operating Procedure. Technical Bulletin No. MK3140.

SOP EN-101 – Field Records

SOP EN-102 – Chain of Custody Procedures

SOP EN-103 – Packaging and Shipment of Environmental Samples

SOP EN-105 – Decontamination of Field Equipment

SOP EN-106 –Investigative Derived Waste Management.SOP EN-503 – Photoionization Detector Measurement

Table 1 Geoprobe Systems® Soil Sampler Characteristics

Sampler Type	Lengt h (in.)	Diameter (in.)	Volume (ml)	Sleeve Liner Type	Suitability[1]			
					Soil Logging	Physical Testing	Chemical-Inorganics	Chemical-Organics
Dual Tube DT22	60	1.125	980	PVC	A	A	A	A
Dual Tube DT325	60	1.85	2,600	PVC	A	A	A	A
Macro-Core®	60	1.5	1,300	Acetate Stainless Steel Teflon® PVC	A B A A	A A A A	A B A A	B A A A
Large Bore	24	1.06	320	Acetate Brass Stainless Steel Teflon®	A B B A A	A A A A A	A B B A A	B B A A A

[1] A - Preferred suitability
B - Acceptable suitability

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Figure 1 – Soil Sampling Tools – Dual Tube Sampling System - Parts (DT22 version)

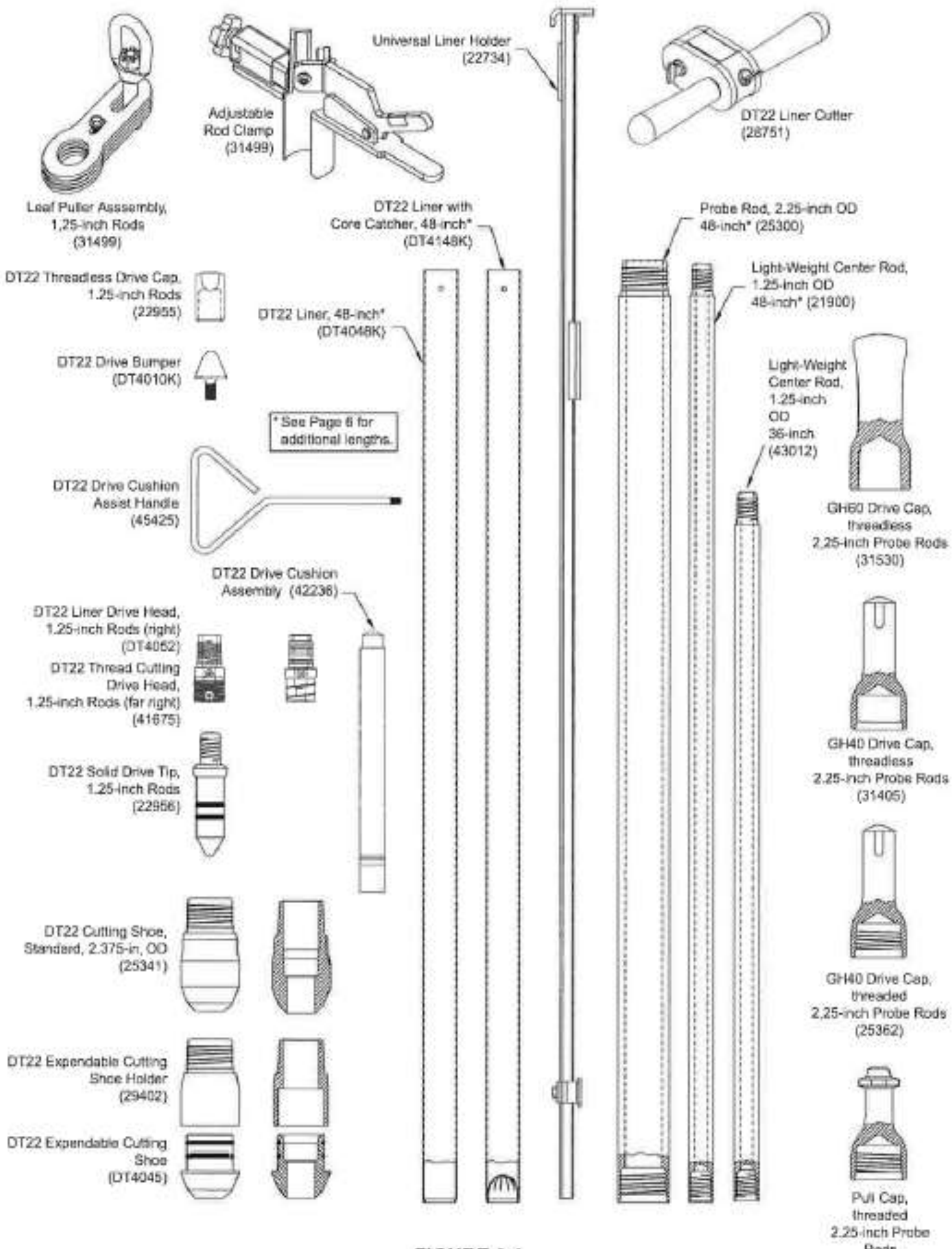

FIGURE 3.1
Dual Tube 22 Soil Sampling System Parts

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Figure 2 – Soil Sampling Tools – Macro-Core® Sampler - Parts

SOIL SAMPLING TOOLS - Macro-Core Sampler - Parts

Macro-Core Sampler

AT-720 Series

The sampler features a nickel-plated sample tube that is 48" long x 2.0" in diameter, a hardened tool steel cutting shoe that has a 1.5" diameter opening, and a tapered drive head that fits standard Geoprobe probe rods. The overall length assembled is 51.25". Sample recovery is 45" long x 1.50" diameter (1302 ml) in a PETG liner.

PARTS	
AT-720	MC Cutting Shoe
AT-721	MC Drive Head
AT-722	MC Sample Tube
AT-725	MC PETG (clear plastic) Liner
AT-726	MC Vinyl End Cap
AT-727	MC Shoe Wrench

KITS

Assembled Macro-Core Sampler*
Part No. AT-720K
Includes the following parts:
(1) **AT-720** MC Cutting Shoe
(1) **AT-721** MC Drive Head
(1) **AT-722** MC Sample Tube
*kit does not include liners and end caps

LINERS	
AT-725K	MC PETG Liners (pre-flared, clear plastic) Box of 66 only
AT-726K	MC Vinyl End Caps (fit AT-725 liners) Box of 66 pairs (66 red/66 black)

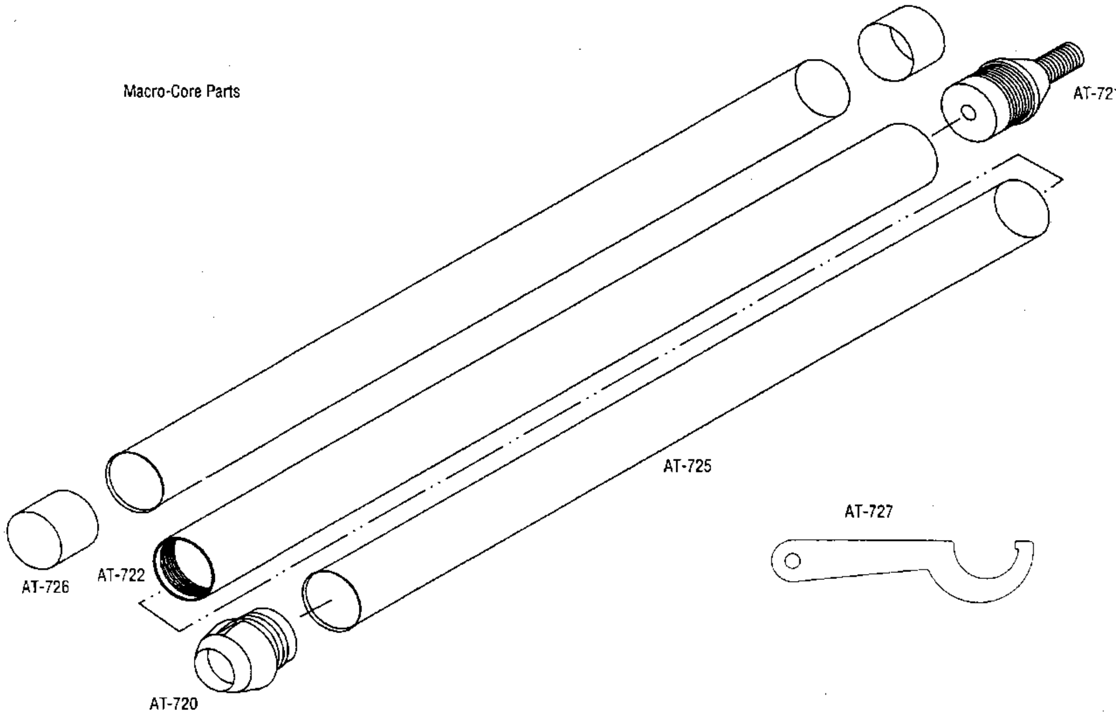

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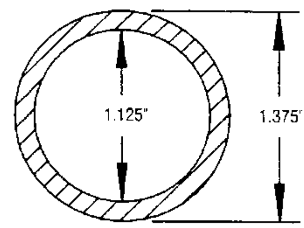
Figure 3 – Soil Sampling Tools – Probe Drive System/Large Bore

SOIL SAMPLING TOOLS - Probe Drive System/Large Bore

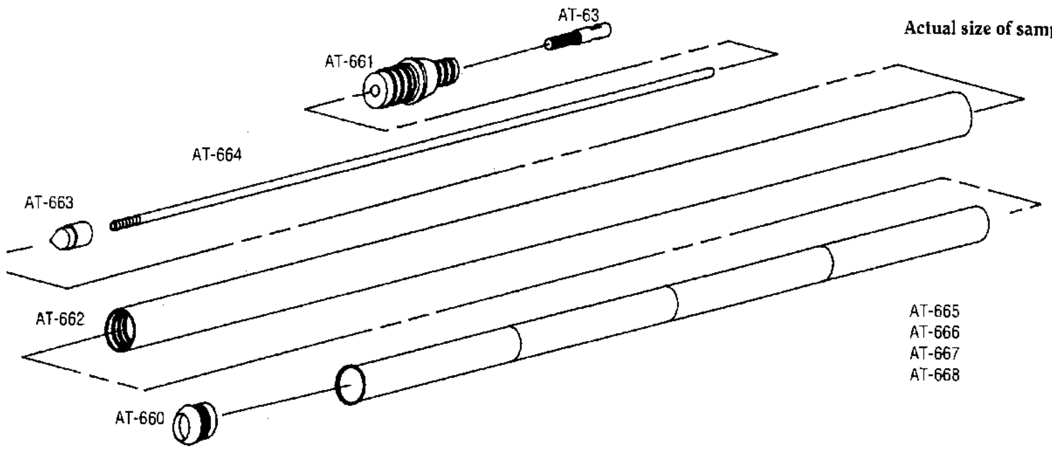
Large Bore Sampler
AT-660 Series

Features nickel plated sample tube, replaceable hardened tool steel cutting shoe and removable liner. Recovers core approximately 22" long x 1-1/16" diameter (320 ml). Uses STD Piston Stop-Pin. Recommended for sampling depths up to 30 feet. Liners available in brass, stainless steel, PTFE (Teflon), or PETG (clear plastic).

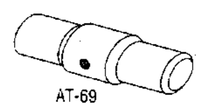


Actual size of sample tube

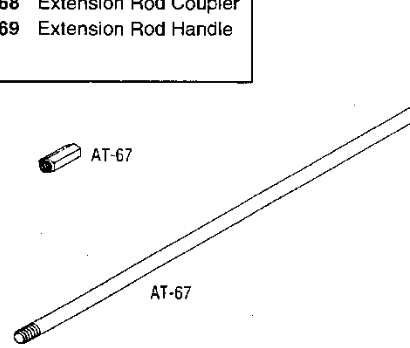
Large Bore Sampler Parts:



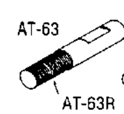
PARTS					
Large Bore Sampler Parts		**Liners**		**Also required:**	
AT-660	LB Cutting Shoe	**AT-665**	LB PETG Liner	**AT-63**	STD Stop-Pin
AT-661	LB Drive Head	**AT-666**	LB Brass Liner	**AT-63R**	Stop-Pin O-rings
AT-662	LB Sample Tube	**AT-667**	LB Stainless Liner	**AT-67**	Extension Rod
AT-663	LB Piston Tip	**AT-668**	LB PTFE Liner	**AT-68**	Extension Rod Coupler
AT-664	LB Piston Rod			**AT-69**	Extension Rod Handle
AT-669	LB Shoe Wrench				



PARTS	
Parts used with all Probe-Drive Samplers	
AT-63	STD Stop-Pin
AT-63R	Stop-Pin O-rings
AT-67	Extension Rod
AT-68	Extension Rod Coupler
AT-69	Extension Rod Handle



Extension Rod Parts



Stop-Pin Parts

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Figure 4 Typical Boring Log

Client:	***LOCATION ID:***
Site Location:	
Task:	
Date/Time Core Collected:	*Sheet:* _____ *of* _____
Date/Time Core Logged:	
Logged By:	*Settled Recovery:*
Top of Casing Observations:	
	Sample Time:

BORING COMPLETION DETAIL

Depth (ft)	Depth to Groundwater	U.S.C.S.	**MATERIALS: Color, CLASSIFICATION (USCS - ASTM D2488), moisture, plasticity, cohesiveness, sedimentary structure, secondary grain size, other.**	Sample ID	UV Light Observations		Depth (ft)
					Core	Pan	

NOTES:

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Enbridge Line 6B MP 608

Marshall, MI Pipeline Release

Subsurface Soil Sampling by Hollow Stem Auger and Split-Spoon Sampler Methods– SOP EN-302

Prepared for Michigan Department of Environmental Quality

Enbridge Energy, Limited Partnership

Submitted: November 11, 2010

Approved: August 30, 2011

FIGURES

Approved

LIST OF ACRONYMS

HASP	Health and Safety Plan
HSA	Hollow Stem Auger
MDEQ	Michigan Department of Environmental Quality
MS/MSD	Matrix Spike/Matrix Spike Duplicate
OSHA	Occupational Safety and Health Administration
QAPP	Quality Assurance Project Plan
QC	Quality Control
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedure
U.S. EPA	United States Environmental Protection Agency
VOCs	Volatile Organic Compounds

1.0 SCOPE & METHOD SUMMARY

1.1 Purpose and Applicability

This Standard Operating Procedure (SOP) describes the basic techniques/procedures and general considerations to be followed for collecting subsurface soil samples using Hollow Stem Auger (HSA) and split-spoon sampler equipment. Subsurface soil samples may be obtained using this system for purposes of determining subsurface soil conditions and for obtaining soil samples for physical and/or chemical evaluation.

The sampling methods covered in this SOP are applicable to unconsolidated soil/fill materials. Sample recovery is somewhat dependent on grain size as very coarse gravel, cobbles, and boulders will occasionally cause premature refusal of the sample tooling. It is generally preferable to have some prior knowledge of site soil conditions if sampling activities are proposed where equipment limitations may become a factor.

It is expected that the procedures outlined in this SOP will be followed. Procedural modifications may be warranted depending on field conditions, equipment limitations, or limitations imposed by the procedure. Substantive modification to this SOP will be noted in task-specific work plans or on *Field Modification Forms* as appropriate and will be approved in advance by the Task Manager. Deviations from the SOP will be documented in the project records and in subsequent reports.

1.2 General Principles

Soil sampling using the split spoon sampler requires use of a 140 pound weight dropped 30 inches *(ASTM Method D1586)* if blow counts are required for geotechnical purposes or a hydraulically-powered percussion hammer to drive the sampler. The manual or hydraulic hammer drives the split spoon sampler vertically into the undisturbed soil ahead of the HSA. The soil sampler is then extracted from the ground to recover the sample.

The split-spoon sampler (*Figure 1*) consists of a 2-inch diameter by 2-foot long open-ended steel sampling tool that can be split in half by unscrewing the drive shoe. The sampler is attached to drilling rods and lowered through the HSAs where it is then driven ahead of the lead auger. Once the sampler is removed from the ground, the drive shoe is removed and the spoon is split in half, exposing the soil to be evaluated. This sampling tool is most often used for soil profiling and collection of soil samples.

2.0 PERSONNEL QUALIFICATIONS

2.1 Field Staff

It is the responsibility of the field staff to conduct subsurface soil sampling in a manner which is consistent with this SOP. Field staff will observe all activities pertaining to subsurface soil sampling to ensure that the SOP is followed, and to record all pertinent data into a digital capture device, onto a boring log or into field logbook. It is also the responsibility of field staff to indicate the specific targeted sampling depth or sampling interval to the drilling subcontractor. Field staff will also collect representative environmental or lithologic characterization samples once the sampling device has been retrieved and opened. Additional sample collection responsibilities include labeling, handling, and storage of samples until further chain of custody procedures are implemented.

Field personnel must be health and safety certified as specified by the *Occupational Safety and Health Administration (OSHA) (29 CFR 1910.120(e)(3)(i))* to work on sites where hazardous waste materials may be present.

2.2 Drilling Subcontractor

It is the responsibility of the drilling subcontractor to provide the necessary tooling for obtaining subsurface soil samples. This generally includes the truck or All Terrain Vehicle-mounted HSA drilling rig and one or more split-spoon samplers in good operating condition, and other necessary equipment for borehole preparation and sampling. Equipment decontamination materials should also be provided by the subcontractor and should meet project specifications.

Drilling personnel must be health and safety certified as specified by OSHA to work on sites where hazardous waste materials may be present.

3.0 HEALTH AND SAFETY

The health and safety considerations for the work associated with this SOP, including both potential physical and chemical hazards, is addressed in the site specific *Health and Safety Plan (HASP)* (Enbridge, 2010). All work will be conducted in accordance with the HASP.

Boring completion may involve physical and/or chemical hazards associated with exposure to water, sediment, or materials in contact with either water or sediment. When sediment sampling is performed, adequate health and safety measures must be taken to protect field personnel. These measures are addressed in the project HASP.

4.0 INTERFERENCES

Potential interferences could result from cross-contamination between borehole locations. Minimization of the cross-contamination will occur through the use of clean sampling tools at each location, which will require decontamination of sampling equipment as per *SOP EN-105 – Decontamination of Field Equipment*.

5.0 EQUIPMENT & SUPPLIES

In addition to those materials provided by the subcontractor, the following equipment list contains materials which may be needed in carrying out the procedures contained in this SOP. Not all equipment listed below may be necessary for a specific activity. Additional equipment may be required, pending field conditions.

- Boring Logs or electronic data collected (such as Trimble Yuma® or equivalent),
- Teaspoon, spatula, or equivalent,
- Sample kit (bottles, labels, custody records, tape, cooler, and ice),
- Sample collection pan (if collecting a composite sample),
- Folding rule or tape measure,
- Equipment decontamination materials (as required by the *Quality Assurance Project Plan (QAPP)* (Enbridge, 2011b)),
- Health and safety equipment (as required by the HASP),
- Field project notebook, camera and pen,
- Work plan including site map and boring locations, and
- Ziplock – style bags.

Sampling equipment which comes in direct contact with environmental samples during the sample collection process should be constructed of stainless steel, Teflon®, or glass, unless specified otherwise in the work plan or QAPP.

6.0 METHODS

6.1 General Method Description

Split-spoon soil sampling methods generally involve collection of soil samples by driving the split-spoon sampler through the HSAs directly into the undisturbed soil ahead of the lead auger using the weight drop or percussion hammer.

When the split-spoon sampler is retrieved from the borehole, the drive shoe is removed, and the barrel is split in half to access the retrieved material. Field staff is then given access to the sample for visual examination/viewing and for whatever purpose is required.

6.2 Equipment Decontamination

Each sampling device must be decontaminated prior to its initial use and following collection of each soil sample, especially if sampling for analytical testing purposes is conducted. If sampling for soil logging only is conducted, thorough sampler decontamination between samples may not be necessary although sufficient cleansing is necessary for the sampler to operate properly. Site-specific requirements for equipment decontamination are outlined in this Sampling and Analysis Plan (*SAP)* (Enbridge, 2011a). Equipment decontamination procedures are also outlined within *SOP EN-105 - Decontamination of Field Equipment*.

6.3 Sampling Procedure – Split-Spoon Sampler

6.3.1 Sample Tooling

- Decontaminate the sampler parts (drive head, cutting shoe, and sample barrel) before assembly.
- Assemble the sampler by first placing the catch basket in the cutting shoe. Then assemble the two halves of the sample barrel and thread the cutting shoe and drive head onto the sample barrel. Tighten the drive head and cutting shoe with a pipe wrench.
- Thread the assembled sampler onto the drilling rod.

6.3.2 Sampling

- Lower the sampler to the bottom of the borehole by adding the appropriate amount of drilling rods.

- Drive the split-spoon sampler 24 inches (if a 24-inch sampler is used) and record the number of blow counts per 6 inches as appropriate.
- Use the drilling rig to pull the sampler from the borehole.

6.3.3 Sample Recovery

- Once the sampler has been removed from the borehole, the sampler must be unthreaded from the drilling rods and the drive head and cutting shoe unthreaded from the sample barrel.
- The sample barrel is split which contains the soil sample. The recovered soil sample may now be viewed, logged, and removed from the barrel for analysis.

6.4 Sample Containment

6.4.1 General

- Once the barrel has been split, the soil sample may be extracted from the sample barrel with a spoon or spatula. Then, the sample should be placed directly into the required sample container.
- Once filled, the sample container should be properly capped, cleaned, labeled and recorded in the field book. Sample chain of custody and preservation procedures should then be initiated.
- Perform equipment decontamination following collection of the sample.

6.4.2 Sampling for Volatile Organic Samples (VOC)s

- Create a clean workspace using clean polyethylene sheeting.
- Put on clean gloves immediately before sampling.
- Decontaminate the field scale and calibrate it with the 10-gram weight provided. Use the scale and weigh an empty syringe. Write the weight of the empty syringe in your field notebook. Take the hand auger sample, or sample from whatever collection device you are using, and insert the open end of the syringe into a fresh face of undisturbed soil (if possible). The VOC sample may be collected from the sample location by inserting the plastic syringe tool directly into the soil
- Push the syringe into the soil and fill it to the point where you believe that you have 10 grams of soil (you may wish to practice filling and weighing the syringe with similar soil

from the same sampling location prior to taking your actual sample in order to get an idea of how much soil is required for a 10-gram sample).

- Using your gloved index finger, thumb, or other instrument, push the soil deeper into the syringe. Note that any material (gloves, instruments, etc.) touching the sample must be decontaminated and clean. Attempt to obtain an area at the opening of the syringe clear of soil. This will assist you in minimizing the amount of contaminants that will adhere to the scale.
- Weigh the soil-filled syringe with the field scale and write the weight in your field notebook.
- Subtract the weight of the syringe from the total weight of syringe and soil (soil must weigh 10 grams +/- 1 gram tolerance for a 9- to 11-gram range, WITHOUT the weight of the syringe). If you do not have 10 +/- 1 grams of soil, you MUST repeat steps 4 through 6, above, until you have a total of 10 +/- 1 grams of soil. For most soils, the same volume of soil will yield approximately the same weight of soil. If you have too much soil, you must remove the excess soil from the syringe until you fall within the 9- to 11-gram range.
- Write the soil weight in your field notebook. You do not need to provide the weight of the sample to the Laboratory; they will reweigh the sample upon receipt.
- Remove the cap from the 40-ml vial.
- Insert the open end of the syringe into the vial, push the plunger, and discharge the soil.
- Place cap TIGHTLY on the 40-ml vial and gently shake it for ten seconds.

7.0 DATA & RECORDS MANAGEMENT

The data associated with hollow stem auger split spoon sampling may be contained on the following:

- Sample labels,
- Chain of custody records and custody seal(s),
- Boring logs (example shown as *Figure 2* or equivalent),
  - Field Screen results/observations and sample collection locations/intervals will be included on the Boring Log.
- Field logbook,
- Sample collection records,
- Electronic data collection (Trimble Yuma® or equivalent),
- *Field Modification Forms* (used prior to field work, when required), and
- *Nonconformance Records* (used after field work, when required).

The following SOPs describe the data collection and record management procedures that should be followed as part of the sample collection process:

- *SOP EN-101 Field Records,*
- *SOP EN-102 Chain of Custody Procedures, and*
- *SOP EN-103 Packaging and Shipment of Environmental Samples.*

See the referenced SOPs for additional details.

8.0 QUALITY ASSURANCE AND QUALITY CONTROL

Quality Control (QC) samples collected via hollow stem auger methods may include field duplicates, equipment and/or field blanks, trip blanks, and matrix spike/matrix spike duplicates (MS/MSD). See the QAPP for collection frequency and methods.

Approved

9.0 REFERENCES

Enbridge, 2011a. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Sampling and Analysis Plan (SAP). August 30, 2011.

Enbridge, 2011b. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Quality Assurance Project Plan (QAPP). August 19, 2011.

Enbridge, 2010. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Health and Safety Plan (HASP). August 2010.

ASTM Method D 1586-08a, *Standard Test Method for Standard Penetration Test (STP0 and Split-Barrel Sampling of Soil*, ,ASTM Committee on Standards, Philadelphia, PA.

SOP EN-101 – Field Records

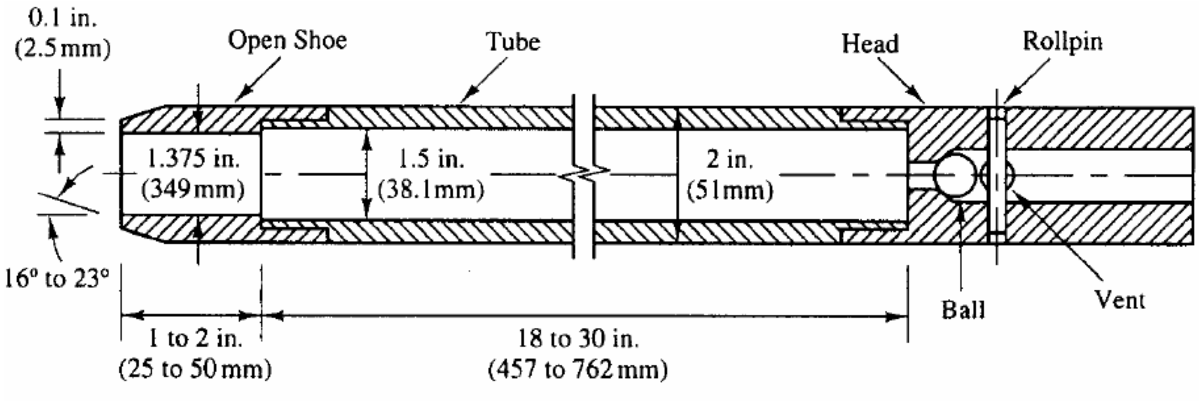
SOP EN-102 – Chain of Custody Procedures

SOP EN-103 – Packaging and Shipment of Environmental Samples

SOP EN-105 – Decontamination of Field Equipment

Approved

Figure 1 – Split-Spoon Sampler



Approved

Figure 2 Typical Boring Log

Client:	***LOCATION ID:***
Site Location:	
Task:	
Date/Time Core Collected:	*Sheet: _____ of _____*
Date/Time Core Logged:	
Logged By:	*Settled Recovery:*
Top of Casing Observations:	
	Sample Time:

BORING COMPLETION DETAIL

Depth (ft)	Depth to Groundwater	U.S.C.S.	**MATERIALS: Color, CLASSIFICATION (USCS - ASTM D2488), moisture, plasticity, cohesiveness, sedimentary structure, secondary grain size, other.**	Sample ID	UV Light Observations		Depth (ft)
					Core	Pan	

NOTES:

Approved

Enbridge Line 6B MP 608

Marshall, MI Pipeline Release

Subsurface Soil Sampling by Sonic Drilling Methods– SOP EN-303

Prepared for Michigan Department of Environmental Quality

Enbridge Energy, Limited Partnership

Submitted: November 11, 2010

Approved: August 30, 2011

FIGURE

Approved

LIST OF ACRONYMS

HASP	Health and Safety Plan
OSHA	Occupational Safety and Health Administration
QAPP	Quality Assurance Project Plan
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedure
U.S. EPA	United States Environmental Protection Agency
VOCs	Volatile Organic Compounds

1.0 SCOPE & METHOD SUMMARY

1.1 Purpose and Applicability

This Standard Operating Procedure (SOP) describes the basic techniques and general considerations to be followed for collecting subsurface soil samples using sonic drilling equipment. Subsurface soil samples may be obtained using this system for purposes of determining subsurface soil conditions and for obtaining soil samples for physical and/or chemical evaluation.

The purpose of this SOP is to provide a description of a specific method or procedure to be used in the collection of subsurface soil samples using the sonic drilling method. Sonic drilling is used primarily for deep borings that may penetrate bedrock. This SOP describes procedures for drilling unconsolidated soils. *SOP EN-306* describes procedures for sonic bedrock drilling. Subsurface soil is defined as unconsolidated material which may consist of one or a mixture of the following materials: sand, gravel, silt, clay, peat (or other organic soils), and fill material. Subsurface soil sampling, conducted in accordance with this SOP will promote consistency in sampling and provide a basis for sample representativeness.

The sampling methods covered in this SOP are applicable to unconsolidated soil/fill materials. Sample recovery is somewhat dependent on grain size as very coarse gravel, cobbles, and boulders will occasionally cause premature refusal of the sample tooling. It is generally preferable to have some prior knowledge of site soil conditions if sampling activities are proposed where equipment limitations may become a factor.

It is expected that the procedures outlined in this SOP will be followed. Procedural modifications may be warranted depending on field conditions, equipment limitations, or limitations imposed by the procedure. Substantive modification to this SOP will be noted in specific Work Plans or on Field Modification Forms as appropriate and will be approved in advance by the Task Manager. Deviations from the SOP will be documented in the project records.

1.2 General Principles

Soil sampling using the sonic drilling method requires use of a sonic drilling rig to advance the core barrel vertically into the undisturbed soil ahead of the outer casing. The core barrel is then extracted from the outer casing to recover the sample.

The typical sonic sampling method consists of a 4-inch diameter by 10-foot long open-ended steel core barrel that fits through a 6-inch diameter outer casing. The core barrel is attached to drill stem and vibrated ahead of the outer casing. Once the core barrel is removed from the ground, the soil is vibrated out of the core barrel and into a plastic sleeve, exposing the soil to be evaluated. This sampling tool is most often used for soil profiling and collection of soil samples. In situations where deeper depths may be required, or multiple wells may be installed in the boring, larger core barrels and override casing may be used.

2.0 PERSONNEL QUALIFICATIONS

2.1 Field Staff

It is the responsibility of the field staff to conduct subsurface soil sampling in a manner which is consistent with this SOP. Field staff will observe all activities pertaining to subsurface soil sampling to ensure that the SOP is followed, and to record all pertinent data into a digital capture device, onto a boring log or into a field logbook. It is also the responsibility of field staff to indicate the specific targeted sampling depth or sampling interval to the drilling subcontractor. Field staff will collect representative environmental or stratigraphic characterization samples once the sampling device has been retrieved and the sample is placed in the plastic sleeve. Additional sample collection responsibilities include labeling, handling, and storage of samples until further chain of custody procedures are implemented.

Field personnel must be health and safety certified as specified by the *Occupational Safety and Health Administration (OSHA) (29 CFR 1910.120(e)(3)(i))* to work on sites where hazardous waste materials may be present.

2.2 Drilling Subcontractor

It is the responsibility of the drilling subcontractor to provide the necessary tooling for obtaining subsurface soil samples. This generally includes the sonic drilling rig and one or more core barrels in good operating condition, and other necessary equipment for borehole preparation and sampling. Equipment decontamination materials should also be provided by the subcontractor and should meet project specifications. Drilling personnel must be health and safety certified as specified by *OSHA* to work on sites where hazardous waste materials may be present.

3.0 HEALTH AND SAFETY

The health and safety considerations for the work associated with this SOP, including both potential physical and chemical hazards, are addressed in the site specific *Health and Safety Plan (HASP)* (Enbridge, 2010). All work will be conducted in accordance with the HASP.

Subsurface soil sampling by sonic drilling methods may involve physical and/or chemical hazards associated with exposure to soil, water, sediment, or materials in contact with either soil, water, or sediment. When soil sampling is performed, adequate health and safety measures must be taken to protect field personnel. These measures are addressed in the project HASP.

4.0 INTERFERENCES

Potential interferences could result from cross-contamination between borehole locations. Minimization of the cross-contamination will occur through the use of clean sampling tools at each location, which will require decontamination of sampling equipment per *SOP EN-105 Decontamination of Field Equipment*.

5.0 EQUIPMENT & SUPPLIES

In addition to those materials provided by the subcontractor, the following equipment list contains materials which may be needed in carrying out the procedures contained in this SOP. Not all equipment listed below may be necessary for a specific activity. Additional equipment may be required, pending field conditions.

- Boring Logs or electronic data collected (such as Trimble Yuma® or equivalent),
- Teaspoon, spatula, or equivalent,
- Sample kit (bottles, labels, custody records, tape, cooler, and ice),
- Sample collection pan (if collecting a composite sample),
- Folding rule or tape measure,
- Equipment decontamination materials (as required by in the *Quality Assurance Project Plan (QAPP)*(Enbridge, 2011b)),
- Health and safety equipment (as required by HASP), and
- Field project notebook and pen.

Sampling equipment which comes in direct contact with environmental samples during the sample collection process should be constructed of stainless steel, Teflon®, or glass, unless specified otherwise in the Work Plan or QAPP.

Other materials that may be required:

- Potable water supply,
- Plastic sheeting,
- Trash bags,
- Paper towels, and
- Appropriate containers and materials to manage investigation-derived waste (as specified in this *Sampling and Analysis Plan (SAP)* (Enbridge, 2011a) and Work Plan and as required *by SOP EN-106 - Investigative Derived Waste Management*.

6.0 METHODS

6.1 General Method Description

Sonic sampling methods generally involve collection of soil samples by vibrating the core barrel directly into the undisturbed soil ahead of the outer casing.

When the core barrel is retrieved from the borehole, the soil is vibrated from the core barrel into a plastic sleeve to access the retrieved material. Field staff is then given access to the sample for whatever purpose is required.

Potable water may be introduced during advancement of the outer casing and core barrel. The volume of water introduced will be recorded in the field logbook and/or drilling log. If a monitoring well will be installed, then a minimum of three (3) times the volume introduced will be removed from the well during development.

6.2 Equipment Decontamination

Each core barrel must be decontaminated prior to its initial use and following collection of each soil sample, especially if sampling for analytical testing purposes is conducted. If sampling for soil logging only is conducted, thorough sampler decontamination between samples may not be necessary although sufficient cleansing is necessary for the sampler to operate properly. Site-specific requirements for equipment decontamination are outlined in this SAP. Equipment decontamination procedures are also outlined within *SOP EN-105 - Decontamination of Field Equipment*.

6.3 Sampling Procedure – Core Barrel

6.3.1 Sample Tooling

- Decontaminate the core barrel.
- Thread the core barrel onto the drill stem.

6.3.2 Sampling

- Lower the core barrel to the bottom of the borehole by adding the appropriate amount of drill stem.
- Advance the core barrel ahead of outer casing.

- Advance the outer casing to the terminal depth of the core barrel.
- Use the drilling rig to pull the core barrel from the borehole.

6.3.3 Sample Recovery

- Once the core barrel has been removed from the borehole, the soil is removed from the barrel by vibrating the core barrel and placing the soil into a plastic sleeve.
- The recovered soil sample may now be viewed, logged, and removed from the plastic sleeve for analysis.

6.3.4 Investigation Derived Waste

Investigation derived waste (IDW) generated during sonic drilling will be managed as specified in *SOP EN-106*.

6.3.5 Borehole Abandonment

From the base of the borehole to the estimated groundwater surface, a bentonite seal or a cement grout will be installed. In the case of a bentonite seal, chips or pellets will be poured into the borehole and hydrated with potable water. In the case of cement/bentonite grout, this material will be tremmied into the borehole. The grout mixture will be a ration of bentonite to cement of between 1:5 and 1:20. The grout will be chosen by the drilling contractor based on site conditions with a higher percentage of bentonite used for formations of higher porosity.

For borings that do not intersect the water table, the borehole will be sealed with bentonite chips hydrated with potable water.

6.4 Sample Containment

6.4.1 General

- In general, soil may be extracted from the plastic sleeve with a spoon or spatula. Then the sample should be placed directly into the required sample container.

- Once filled, the sample container should be properly capped, preserved, cleaned, labeled, and recorded in the field book.. Sample chain of custody and preservation procedures should then be initiated.
- Perform equipment decontamination following collection of the sample.

6.4.2 Sampling for Volatile Organic Compounds

For each VOC sample location, collect soil samples using the following procedure:

- Create a clean workspace using clean polyethylene sheeting.
- Put on clean gloves immediately before sampling.
- Decontaminate the field scale and calibrate it with the 10-gram weight provided. Use the scale and weigh an empty syringe. Write the weight of the empty syringe in your field notebook. Take the sample from the Sonic core, and insert the open end of the syringe into a fresh face of undisturbed soil (if possible). The VOC sample may be collected from the sample location by inserting the plastic syringe tool directly into the soil
- Push the syringe into the soil and fill it to the point where you believe that you have 10 grams of soil (you may wish to practice filling and weighing the syringe with similar soil from the same sampling location prior to taking your actual sample in order to get an idea of how much soil is required for a 10-gram sample).
- Using your gloved index finger, thumb, or other instrument, push the soil deeper into the syringe. Note that any material (gloves, instruments, etc.) touching the sample must be decontaminated and clean. Attempt to obtain an area at the opening of the syringe clear of soil. This will assist you in minimizing the amount of contaminants that will adhere to the scale.
- Weigh the soil-filled syringe with the field scale and write the weight in your field notebook.
- Subtract the weight of the syringe from the total weight of syringe and soil (soil must weigh 10 grams +/- 1 gram tolerance for a 9- to 11-gram range, WITHOUT the weight of the syringe). If you do not have 10 +/- 1 grams of soil, you MUST repeat steps 4 through 6, above, until you have a total of 10 +/- 1 grams of soil. For most soils, the same volume of soil will yield approximately the same weight of soil. If you have too much soil, you

must remove the excess soil from the syringe until you fall within the 9- to 11-gram range.

- Write the soil weight in your field notebook. You do not need to provide the weight of the sample to the Laboratory; they will reweigh the sample upon receipt.
- Remove the cap from the 40-ml vial.
- Insert the open end of the syringe into the vial, push the plunger, and discharge the soil.
- Place cap TIGHTLY on the 40-ml vial and gently shake it for ten seconds.
- Completely fill out the sample label on the 40-ml vial.

7.0 DATA & RECORDS MANAGEMENT

The data associated with subsurface soil sampling by sonic drilling may be contained within the following:

- Sample labels,
- Chain of custody records and custody seal(s),
- Boring logs (example shown as *Figure 1* or equivalent),
    - Field Screen results/observations and sample collection locations/intervals will be included on the Boring log.
- Field logbook,
- Sample collection records,
- Electronic data collection (Trimble Yuma® or equivalent),
- Field Modification Forms (used prior to field work, when required), and
- Nonconformance Records (used after field work, when required).

The following SOPs describe the data collection and record management procedures that should be followed as part of the sample collection process:

- *SOP EN-101 Field Records,*
- *SOP EN-102 Chain of Custody Procedures, and*
- *SOP EN-103 Packaging and Shipment of Environmental Samples.*

See the referenced SOPs for additional details.

8.0 QUALITY ASSURANCE AND QUALITY CONTROL

Quality Control (QC) samples collected via sonic drilling may include field duplicates, equipment and/or field blanks, trip blanks, and matrix spike/matrix spike duplicates (MS/MSD). See the QAPP for collection frequency and methods.

9.0 REFERENCES

Enbridge, 2011a. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Sampling and Analysis Plan (SAP). August 30, 2011.

Enbridge, 2011b. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Quality Assurance Project Plan (QAPP). August 19, 2011.

Enbridge, 2010. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Health and Safety Plan (HASP). August 2010.

SOP EN-101 – Field Records

SOP EN-102 – Chain of Custody Procedures

SOP EN-103 – Packaging and Shipment of Environmental Samples

SOP EN-105 – Decontamination of Field Equipment

SOP EN-106 –Investigative Derived Waste Management.

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Figure 1 Boring Log

Client:	***LOCATION ID:***
Site Location:	
Task:	
Date/Time Core Collected:	*Sheet: _____ of _____*
Date/Time Core Logged:	
Logged By:	*Settled Recovery:*
Top of Casing Observations:	
	Sample Time:

BORING COMPLETION DETAIL

Depth (ft)	Depth to Groundwater	U.S.C.S.	**MATERIALS: Color, CLASSIFICATION (USCS - ASTM D2488), moisture, plasticity, cohesiveness, sedimentary structure, secondary grain size, other.**	Sample ID	UV Light Observations		Depth (ft)
					Core	Pan	

NOTES:

Approved

Enbridge Line 6B MP 608

Marshall, MI Pipeline Release

Surface Soil Sampling – SOP EN-304

Prepared for Michigan Department of Environmental Quality

Enbridge Energy, Limited Partnership

Submitted: November 11, 2010

Approved: August 30, 2011

Approved

LIST OF ACRONYMS

GPS	Global Positioning System
HASP	Health and Safety Plan
MS/MSD	Matrix Spike/Matrix Spike Duplicate
QAPP	Quality Assurance Project Plan
QC	Quality Control
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedure
VOCs	Volatile Organic Compounds

Approved

1.0 SCOPE & METHOD SUMMARY

1.1 Purpose and Applicability

This standard operating procedure (SOP) describes the basic techniques and general considerations to be followed for obtaining surface soil samples for physical and/or chemical analysis. For purposes of this SOP, surface soil (including shallow subsurface soil) is loosely defined as soil that is present within one foot of the ground surface and can be sampled with the use of readily available and easy-to-operate sampling equipment.

The purpose of this SOP is to provide a specific method and/or procedure to be used in the collection of surface soil samples which, if followed properly, will promote consistency in sampling and provide a basis for sample representativeness.

This SOP is generally applicable to surface soils which are unconsolidated and are of low to moderate density. Higher density or compacted soils may require use of drill rigs or other powered equipment to effectively obtain representative samples.

It is expected that the procedures outlined in this SOP will be followed. Procedural modifications may be warranted depending on field conditions, equipment limitations, or limitations imposed by the procedure. Substantive modification to this SOP will be noted in work plans or on Field Modification Forms as appropriate and will be approved in advance by the Task Manager. Deviations from the SOP will be documented in the project records and in subsequent reports.

1.2 General Principles

Surface soil sampling generally involves use of hand-operated equipment to obtain representative soil samples from the ground surface and to shallow depths below the ground surface. If soil conditions are appropriate, surface soil sampling, following the procedures described in this SOP, can provide representative soil samples in an efficient manner.

2.0 PERSONNEL QUALIFICATIONS

It is the responsibility of the field staff to conduct surface soil sampling in a manner which is consistent with this SOP. Field staff will observe all activities pertaining to surface soil sampling to ensure that the SOP is followed, and to record all pertinent data into a digital capture device, onto a boring log or into a field logbook. Additional sample collection responsibilities include labeling, handling, and storage of samples until further chain of custody procedures are implemented.

3.0 HEALTH AND SAFETY

The health and safety considerations for the work associated with this SOP, including both potential physical and chemical hazards, is addressed in the site specific *Health and Safety Plan (HASP)* (Enbridge, 2010). All work will be conducted in accordance with the HASP.

Surface soil sampling may involve physical and/or chemical hazards associated with exposure to water, sediment, or materials in contact with either water or sediment. When sediment sampling is performed, adequate health and safety measures must be taken to protect field personnel. These measures are addressed in the project HASP.

4.0 INTERFERENCES

Potential interferences could result from cross-contamination between samples or sample locations. Additional interference could result from using contaminated equipment, disturbance of the matrix in compaction of the sample or inadequate homogenization of the sample. Minimization of the cross-contamination will occur through the use of clean sampling tools at each location, which will require decontamination of sampling equipment as per *SOP EN-105 – Decontamination of Field Equipment*. Improper sample collection will be minimized by careful adherence to this SOP.

5.0 EQUIPMENT & SUPPLIES

The following equipment list contains materials which may be needed in carrying out the procedures contained in this SOP. Not all equipment listed below may be necessary for a specific activity. Additional equipment may be required, pending field conditions.

- Survey equipment or global positioning system (GPS) to locate sampling points,
- Work Plan including site map and sample parameters,
- Spoons or scoops, trowel, spatula, shovel, or hand or bucket auger,
- Field forms or electronic data collected (such as Trimble Yuma® or equivalent),
- Sample kit (bottles, preservatives, labels, custody records, tape, cooler, and ice),
- Ziplock-style bags,
- Plastic sheeting or tarp,
- Stainless steel, plastic, or other appropriate homogenization bucket, bowl or pan,
- Camera, logbook, and pen,
- Folding rule or tape measure,
- Equipment decontamination materials (as required by *Quality Assurance Project Plan (QAPP)* (Enbridge, 2011)*,* and
- Health and safety equipment (as required by the HASP).

Sampling equipment which comes in direct contact with environmental samples during the sample collection process should be disposable or constructed of stainless steel, Teflon®, or glass, unless specified otherwise in the work plan or QAPP. Chrome plated equipment typically found in hardware stores should not be used for sampling equipment.

For volatile organic compound (VOC) sample collection, the following equipment may be required:

- Clean gloves (the composition of the gloves depends on the material being sampled -- refer to the QAPP and HASP);
- 40-ml glass vials with methanol (from lab);

- Plastic syringe with capacity for 10 ml; and
- Scale (with an accuracy of 0.1 grams) capable of measuring 10 grams

Methanol preserved vials and syringes for soil collection are obtained from the laboratory performing the sample analysis.

6.0 METHOD

6.1 General Method Description

Site-specific soil characteristics such as soil density and moisture will generally dictate the preferred type of sampling equipment for use at a particular site. Similarly, other project-specific requirements such as sampling depth and requested type of analysis such as physical testing (e.g., grain-size distribution) and/or chemical analysis will dictate the use of a preferred type of sampling equipment. Analytical testing requirements will indicate sample volume requirements that also will influence the selection of the appropriate type of sampling tool.

Sample volume and sampling depth requirements are defined in the Work Plan. For samples requiring a large volume of soil, multiple holes and soil compositing may be necessary.

6.2 Equipment Decontamination

Unless disposable or one time use sampling equipment is used, each piece of equipment needs to be decontaminated prior to its initial use and following collection of each individual soil sample. Site-specific requirements for equipment decontamination are outlined within *SOP EN-105 - Decontamination of Field Equipment*.

6.3 Collection of Samples for Volatile Organic Compound Analysis

Collection of surface soil samples for VOC analysis is different than collection of soil samples for other routine physical or chemical testing primarily because of the concern for potential loss of volatiles during the normal sample collection procedure. To limit the potential for loss of volatiles, the soil sample must be obtained as quickly and as directly as possible. This generally means that if a VOC sample is to be collected as part of a multiple analyte sample, the VOC sample portion should be obtained first. The VOC sample should also be obtained from a discrete portion of the entire collected sample and not from a sample which has been composited or homogenized from the entire sample interval. In general, it is best to collect the VOC sample by transferring the sample directly from the sampling tool into the sample bottles. Intermediate sample containers such as collection pans should not be used during collection of VOC samples.

6.4 Standard Procedures

6.4.1 Surface Preparation

At some sampling locations, the ground surface may require preparation in advance of sampling. Surface preparation can include removal of surface debris which blocks access to the actual soil surface or loosening of dense surface soils such as those encountered in heavy traffic areas, or frozen soils. If sampling equipment is used for both removal of surface debris and for collection of the soil sample, the equipment should be decontaminated prior to sample collection to reduce the potential for sample interferences between the surface debris and the underlying soil.

6.4.2 Spoon, Scoop, and Trowel Sampling Procedure

Shovels, spoons, scoops, and trowels are of similarly designed construction and can therefore be operated in accordance with the following procedure.

- Select the sampling location and prepare the surface by removal of surface debris if present. Surface preparation should be completed using other appropriately decontaminated sampling equipment.
- Decontaminate the shovel, spoon, scoop, or trowel in accordance with *SOP EN-105 - Decontamination of Field Equipment* prior to use.
- The soil sample should be obtained by inserting the sampling tool into the ground and rotating the tool so that a representative "column" of soil is removed from the ground.
- The immediate objective is to collect the VOC sample fraction first if this is required. If a specific depth below the ground surface has been targeted for the VOC sample, the overlying soils should be removed and discarded or placed into a soil collection pan as part of the remaining composite sample.
- Regardless of whether or not a VOC sample is required, one or more cores or scoops of soil may be needed until the desired sampling depth is achieved. Removal of a representative column of soil in cohesionless soils may be difficult to achieve. If more soil is needed to meet sample volume requirements, additional columns of soil may be collected from an immediately adjacent location.
- Except for VOC samples, as each portion of the sample is removed from the ground, it should be placed into an intermediate sample container (collection pan or bowl) until the

entire sample interval of soil is removed and all vertical intervals are adequately represented.

- Once the sample interval has been collected, the soil sample should be thoroughly homogenized within the collection pan prior to bottling. Sample homogenizing is accomplished by manually mixing the entire soil sample in the collection pan until a uniform mixture is achieved.
- The appropriate sample containers should be filled with soil from the collection pan.
- Once each sample container is filled, the rim and threads of the sample container will be cleaned of soil, then capped and labeled. Do not submerge the sample containers in water to clean them. Once labeled the sample containers should be placed into a cooler for protection. Sample chain of custody and other documentation requirements should be completed at this time or in the field office.
- The sampling tool and other sampling equipment (if not disposable) should be decontaminated prior to reuse. All investigation derived waste should be properly contained before leaving the area.
- The sample hole should be backfilled to eliminate any surface hazard.

6.4.3 Sampling for Volatile Organic Compounds

For each sample location, collect soil samples using the following procedure:

- Create a clean workspace using clean polyethylene sheeting.
- Put on clean gloves immediately before sampling.
- Decontaminate the field scale and calibrate it with the 10-gram weight provided. Use the scale and weigh an empty syringe. Write the weight of the empty syringe in your field notebook. Take the hand auger sample, or sample from whatever collection device you are using, and insert the open end of the syringe into a fresh face of undisturbed soil (if possible). The VOC sample may be collected from the sample location by inserting the plastic syringe tool directly into the soil
- Push the syringe into the soil and fill it to the point where you believe that you have 10 grams of soil (you may wish to practice filling and weighing the syringe with similar soil from the same sampling location prior to taking your actual sample in order to get an idea of how much soil is required for a 10-gram sample).

- Using your gloved index finger, thumb, or other instrument, push the soil deeper into the syringe. Note that any material (gloves, instruments, etc.) touching the sample must be decontaminated and clean. Attempt to obtain an area at the opening of the syringe clear of soil. This will assist you in minimizing the amount of contaminants that will adhere to the scale.
- Weigh the soil-filled syringe with the field scale and write the weight in your field notebook.
- Subtract the weight of the syringe from the total weight of syringe and soil (soil must weigh 10 grams +/- 1 gram tolerance for a 9- to 11-gram range, WITHOUT the weight of the syringe). If you do not have 10 +/- 1 grams of soil, you MUST repeat steps 4 through 6, above, until you have a total of 10 +/- 1 grams of soil. For most soils, the same volume of soil will yield approximately the same weight of soil. If you have too much soil, you must remove the excess soil from the syringe until you fall within the 9- to 11-gram range.
- Write the soil weight in your field notebook. You do not need to provide the weight of the sample to the Laboratory; they will reweigh the sample upon receipt.
- Remove the cap from the 40-ml vial.
- Insert the open end of the syringe into the vial, push the plunger, and discharge the soil.
- Place cap TIGHTLY on the 40-ml vial and gently shake it for ten seconds.
- Completely fill out the sample label on the 40-ml vial.

7.0 DATA & RECORDS MANAGEMENT

The data associated with surface soil sampling is contained within the following:

- Sample labels,
- Chain of custody records and custody seal(s),
- Field logbook,
- Sample collection records,
- Electronic data collection (Trimble Yuma® or equivalent),
- Field Modification Forms (used prior to field work, when required), and
- Nonconformance Records (used after field work, when required).

The following SOPs describe the data collection and record management procedures that should be followed as part of the sample collection process:

- *SOP EN-101 Field Records,*
- *SOP EN-102 Chain of Custody Procedures,* and
- *SOP EN-103 Packaging and Shipment of Environmental Samples*.

See the referenced SOPs for additional details.

8.0 QUALITY ASSURANCE AND QUALITY CONTROL

Quality Control (QC) samples collected via sonic drilling may include field duplicates, equipment and/or field blanks, trip blanks, and matrix spike/matrix spike duplicates (MS/MSD). See the QAPP for collection frequency and methods.

9.0 REFERENCES

Enbridge, 2010. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Health and Safety Plan (HASP). August 2010.

Enbridge, 2011. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Quality Assurance Project Plan (QAPP). August 19, 2011.

SOP EN-101 - Field Records

SOP EN-102 - Chain of Custody Procedures

SOP EN-103 - Packaging and Shipment of Environmental Samples

SOP EN-105 – Decontamination of Field Equipment.

Approved

Enbridge Line 6B MP 608

Marshall, MI Pipeline Release

Soil Sampling via Hand Auger– SOP EN-305

Prepared for Michigan Department of Environmental Quality

Enbridge Energy, Limited Partnership

Approved: August 30, 2011

Approved

LIST OF ACRONYMS

HASP	Health and Safety Plan
MDEQ	Michigan Department of Environmental Quality
MS/MSD	Matrix Spike/Matrix Spike Duplicate
OSHA	Occupational Safety and Health Administration
PID/FID	Photo- ionization detector/Flame-ionization detector
QAPP	Quality Assurance Project Plan
QC	Quality Control
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedure
VOC	Volatile Organic Compound

Approved

1.0 SCOPE & METHOD SUMMARY

1.1 Purpose and Applicability

This standard operating procedure (SOP) describes the basic techniques and general considerations to be followed for the collection of subsurface soil samples for physical and/or chemical analysis. For purposes of this SOP, subsurface soil is loosely defined as soil that is located greater than one foot from the ground surface and can be sampled with the use of readily available and easy-to-operate sampling equipment. This SOP is generally applicable to subsurface soils which are unconsolidated and are of low to moderate density. Higher density or compacted soils may require use of drill rigs or other powered equipment to effectively obtain representative samples.

It is expected that the procedures outlined in this SOP will be followed. Procedural modifications may be warranted depending on field conditions, equipment limitations, or limitations imposed by the procedure. Substantive modification to this SOP will be noted in task-specific work plans or on Field Modification Forms as appropriate and will be approved in advance by the Task Manager. Deviations from the SOP will be documented in the project records and in subsequent reports.

1.2 General Principles

Subsurface soil sampling generally involves the use of hand-operated equipment to obtain representative soil samples from shallow depths below the ground surface. If soil conditions are appropriate, subsurface soil sampling, following the procedures described in this SOP, can provide representative soil samples in an efficient manner.

2.0 PERSONNEL QUALIFICATIONS

It is the responsibility of the field staff to conduct subsurface soil sampling in a manner which is consistent with this SOP. Field staff will observe all activities pertaining to subsurface soil sampling to ensure that the SOP is followed, and to record all pertinent data into a digital capture device, onto a boring log or into field logbook. Additional sample collection responsibilities include labeling, handling, and storage of samples until chain of custody procedures are implemented.

3.0 HEALTH AND SAFETY

The health and safety considerations for the work associated with this SOP, including both potential physical and chemical hazards, are addressed in the site specific *Health and Safety Plan (HASP)* (Enbrige, 2010).   All work will be conducted in accordance with the HASP.

4.0 INTERFERENCES

Potential interferences could result from cross-contamination between samples or sample locations. Additional interference could result from using contaminated equipment, disturbance of the matrix in compaction of the sample or inadequate homogenization of the sample. Minimization of the cross-contamination will occur through the use of clean sampling tools at each location, which will require decontamination of sampling equipment as per *SOP EN-105 – Decontamination of Field Equipment*. Improper sample collection will be minimized by careful adherence to this SOP.

5.0 EQUIPMENT & SUPPLIES

The following equipment list contains materials which may be needed in carrying out the procedures contained in this SOP. Not all equipment listed below may be necessary for a specific activity. Additional equipment may be required, pending field conditions.

- Survey equipment or global positioning system to locate sampling points;
- Work plan including site map and sample parameters;
- Spoons or scoops, trowel, spatula, shovel, and hand or bucket auger;
- Field forms or electronic data collected (such as Trimble Yuma® or equivalent);
- Sample kit (bottles, labels, custody records, tape, cooler, and ice);
- Ziplock-style bags;
- Plastic sheeting or tarp;
- Stainless steel, plastic, or other appropriate homogenization bucket, bowl or pan;
- Camera, logbook, and pen;
- Folding rule or tape measure;
- Equipment decontamination materials (as required by the *Quality Assurance Project Plan* (*QAPP*) (Enbridge, 2011); and
- Health and safety equipment as required by the HASP.

Sampling equipment which comes in direct contact with environmental samples during the sample collection process should be disposable or constructed of stainless steel, Teflon®, or glass, unless specified otherwise in a work plan or the QAPP. Chrome plated equipment typically found in hardware stores should not be used for sampling equipment.

For volatile organic compound (VOC) sample collection, the following equipment may be required:

- Clean gloves (the composition of the gloves depends on the material being sampled -- refer to the QAPP and HASP);
- 40-ml glass vials with methanol (from lab);
- Plastic syringe with capacity for 10 ml; and
- Scale (with accuracy of 0.1 grams) capable of measuring up to 11 grams.

Methanol preserved vials and syringes for soil collection are obtained from the laboratory performing the sample analysis.

6.0 METHODS

6.1 General Method Description

Site-specific soil characteristics such as soil density and moisture will generally dictate the preferred type of sampling equipment for use at a particular site. Similarly, other project-specific requirements such as sampling depth and requested type of analysis such as physical testing (e.g., grain-size distribution) and/or chemical analysis will dictate the use of a preferred type of sampling equipment. Analytical testing requirements will indicate sample volume requirements that also will influence the selection of the appropriate type of sampling tool.

Sample volume and sampling depth requirements are defined in the work plan. For samples requiring a large volume of soil, multiple holes and soil compositing may be necessary. Collection of the requisite volume of soil to meet sample volume requirements without underestimating the sample volume is the overall objective and is a technique which improves with experience.

6.2 Equipment Decontamination

Unless disposable or one time use sampling equipment is used, each piece of equipment needs to be decontaminated prior to its initial use and following collection of each individual soil sample. Site-specific requirements for equipment decontamination are outlined within *SOP EN-105 - Decontamination of Field Equipment.*

6.3 Collection of Samples for Volatile Organic Compound (VOC) Analysis

Collection of subsurface soil samples for VOC analysis is different than collection of soil samples for other routine physical or chemical testing primarily because of the concern for potential loss of volatiles during the normal sample collection procedure. To limit the potential for loss of volatiles, the soil sample must be obtained as quickly and as directly as possible. This generally means that if a VOC sample is to be collected as part of a multiple analyte sample, the VOC sample portion should be obtained first. The VOC sample should also be obtained from a discrete portion of the entire collected sample and not from a sample which has been composited or homogenized from the entire sample interval. In general, it is best to collect the VOC sample by transferring the sample directly from the sampling tool into the sample bottles. Intermediate sample containers such as collection pans should not be used during collection of VOC samples.

6.4 Standard Procedures

6.4.1 Surface Preparation

At some sampling locations, the ground surface may require preparation in advance of sampling. Surface preparation can include removal of surface debris which blocks access to the actual soil surface or loosening of dense surface soils such as those encountered in heavy traffic areas, or frozen soils. If sampling equipment is used for both removal of surface debris and for collection of the soil sample, the equipment should be decontaminated prior to sample collection to reduce the potential for sample interferences between the surface debris and the underlying soil.

6.4.2 Auger Sampling

- A bucket auger may be used to collect soil samples from depths ranging from one to approximately five feet. In some instances, soil samples may be collected from greater depths, but often with considerable difficulty. Bucket augers allow for discrete depth interval sampling as the soil is retained within the hollow tube of the auger when it is extracted from the ground. It should be noted that if depth-discrete sampling is the objective, more than one auger may be necessary, with one auger used to provide access to the required sampling depth and the other (clean) auger used for sample collection.
- Select the sampling location and prepare the surface by removal of surface debris, if present.
- Decontaminate re-usable equipment in accordance with *SOP EN-105 - Decontamination of Equipment*.
- When using the bucket auger, the auger should be pushed downward and rotated until the bucket becomes filled with soil. Usually a 6 - to 12-inch core of soil is obtained each time the auger is inserted. Once filled, the auger should be removed from the ground and emptied into the soil collection pan or ziplock-style bag. If a VOC sample is required, the sample should be taken directly from the auger using a teaspoon or spatula and/or directly filling the sample container from the auger. The augering process should

be repeated until the desired sample interval has been augered and placed into the collection pan or ziplock-style bags.

- If the desired sample interval is located at a specific depth below the ground surface, the unwanted interval can be removed with one auger and the soil discarded. Sample collection can then proceed in normal fashion using a clean auger or following decontamination of the original auger.
- Except for VOC sample fractions, the remainder of the soil sample should be thoroughly homogenized in the soil collection pan prior to the collection of the sample.
- The appropriate sample containers should be filled with soil from the collection pan. Once each sample container is filled, the rim and threads of the sample container will be cleaned of gross soil, then capped and labeled. Do not submerge the sample containers in water to clean them. Once labeled the sample containers should be placed into a cooler for protection. Sample chain of custody and other documentation requirements should be completed at this time.
- All used sampling equipment should be decontaminated prior to reuse and investigation-derived waste should be properly contained before leaving the area.
- The sample hole should be backfilled with clean soil and/or a combination of clean soil and bentonite chips to eliminate any surface hazard.

6.4.3 Sampling for Volatile Organic Compounds (VOCs)

For each sample location, collect soil samples using the following procedure:

- Create a clean workspace using clean polyethylene sheeting.
- Put on clean gloves immediately before sampling.
- Decontaminate the field scale and calibrate it with the 10-gram weight provided. Use the scale and weigh an empty syringe. Write the weight of the empty syringe in your field notebook.
- Upon exposure of the soil within the sampling implement and headspace screening (if appropriate) with the PID/FID, collect the samples immediately using the following procedure (NOTE: headspace screening should be performed after collection of the VOC samples).
- Take the sample from whatever collection device you are using, and insert the open end of the syringe into a fresh face of undisturbed soil (if possible). The VOC sample may also be collected from the sample location by inserting the plastic syringe tool directly into the soil or the ziplock-style bag.

- Push the syringe into the soil and fill it to the point where you believe that you have 10 grams of soil (you may wish to practice filling and weighing the syringe with similar soil from the same sampling location prior to taking your actual sample in order to get an idea of how much soil is required for a 10-gram sample).
- Using your gloved index finger, thumbs, or other instrument, push the soil deeper into the syringe. Note that any material (gloves, instruments, etc.) touching the sample must be decontaminated and clean. Attempt to obtain an area at the opening of the syringe clear of soil. This will assist you in minimizing the amount of contaminants that will adhere to the scale.
- Weigh the soil-filled syringe with the field scale and write the weight in your field notebook.
- Subtract the weight of the syringe from the total weight of syringe and soil (soil must weigh 10 grams +/- 1 gram tolerance for a 9- to 11-gram range, WITHOUT the weight of the syringe). If you do not have 10 +/- 1 grams of soil, you MUST repeat steps 4 through 6, above, until you have a total of 10 +/- 1 grams of soil. For most soils, the same volume of soil will yield approximately the same weight of soil. If you have too much soil, you must remove the excess soil from the syringe until you fall within the 9- to 11-gram range.
- Write the soil weight in your field notebook. You do not need to provide the weight of the sample to the Laboratory; they will reweigh the sample upon receipt.
- Remove the cap from the 40-ml vial.
- Insert the open end of the syringe into the vial, push the plunger, and discharge the soil.
- Place cap TIGHTLY on the 40-ml vial and gently shake it for ten seconds.
- Completely fill out the sample label on the 40-ml vial.

7.0 DATA & RECORDS MANAGEMENT

The data associated with soil sampling via hang auger will be contained in the following:

- Sample labels,
- Chain of custody records and custody seal(s),
- Boring logs,
- Field logbook,
- Sample collection records,
- Electronic data collection (Trimble Yuma® or equivalent),
- Field Modification Forms (used prior to field work, when required), and
- Nonconformance Records (used after field work, when required).

The following SOPs describe the data collection and record management procedures that should be followed as part of the sample collection process:

- *SOP EN-101 Field Records,*
- *SOP EN-102 Chain of Custody Procedures,* and
- *SOP EN-103 Packaging and Shipment of Environmental Samples.*

See the referenced SOPs for additional details.

8.0 QUALITY ASSURANCE AND QUALITY CONTROL

Quality Control (QC) samples collected via hand auger may include field duplicates, equipment and/or field blanks, trip blanks, and matrix spike/matrix spike duplicates (MS/MSD). See the QAPP for collection frequency and methods.

9.0 REFERENCES

Enbridge, 2010. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Health and Safety Plan (HASP). August 2010.

Enbridge, 2011. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Quality Assurance Project Plan (QAPP). August 19, 2011.

SOP EN 101 – Field Records

SOP EN-102 – Chain of Custody Procedures

SOP EN 103 – Packaging and Shipment of Environmental Samples

SOP EN-105 – Decontamination of Field Equipment

Approved

Enbridge Line 6B MP 608

Marshall, MI Pipeline Release

Bedrock Coring by Sonic Drilling Methods– SOP EN-306

Prepared for Michigan Department of Environmental Quality

Enbridge Energy, Limited Partnership

Approved: August 30, 2011

FIGURE

Approved

LIST OF ACRONYMS

HASP	Health and Safety Plan
MS/MSD	Matrix Spike/Matrix Spike Duplicate
QAPP	Quality Assurance Project Plan
QC	Quality Control
RQD	Rock Quality Designation
SAP	Sampling and Analysis Plan
VOCs	Volatile Organic Compounds

1.0 SCOPE & METHOD SUMMARY

1.1 Purpose and Applicability

This Standard Operating Procedure (SOP) describes the basic techniques/procedures and general considerations to be followed for collecting bedrock cores using sonic drilling equipment. Bedrock cores may be obtained using this technique for purposes of determining subsurface bedrock conditions, obtaining stratigraphic information and for monitoring well installation.

The purpose of this SOP is to provide a description of a specific method or procedure to be used in the collection of bedrock cores using the sonic drilling method. Bedrock is defined as the solid rock that underlies unconsolidated gravel, sand, silt, clay, soil or other surficial material. Bedrock may include a variety of sedimentary rocks including sandstone, shale, and limestone. Bedrock core collection conducted in accordance with this SOP will promote consistency in sampling and provide a basis for sample representativeness.

The sampling methods covered in this SOP are applicable to bedrock or consolidated materials. Sample recovery is somewhat dependent on cementation, hardness, fracturing, and stratigraphic profile. It is generally preferable to have some prior knowledge of site subsurface conditions if sampling activities are proposed where equipment limitations may become a factor.

It is expected that the procedures outlined in this SOP will be followed. Procedural modifications may be warranted depending on field conditions, equipment limitations, or limitations imposed by the procedure. Substantive modification to this SOP will be noted in task-specific work plans or on Field Modification Forms as appropriate and will be approved in advance by the Task Manager. Deviations from the SOP will be documented in the project records and in subsequent reports.

1.2 General Principles

Bedrock coring using the sonic drilling method requires use of a sonic drilling rig to advance the core barrel vertically into the bedrock ahead of the outer casing. The core barrel is then extracted from the outer casing to recover the sample.

The typical sonic drilling equipment consists of a 4-inch diameter by 10-foot long open-ended steel core barrel that fits through a 6-inch diameter outer casing. The core barrel is attached to drill stem and vibrated ahead of the outer casing. Once the core barrel is removed from the ground, the bedrock core is vibrated out of the core barrel and into a plastic sleeve, exposing the sample to be evaluated. This sampling tool is most often used for stratigraphic profiling of both bedrock and unconsolidated subsurface materials, collection of environmental samples, and installation of monitoring wells into bedrock. In situations where deeper depths may be required, or multiple wells may be installed in the boring, larger core barrels and override casing may be used.

2.0 PERSONNEL QUALIFICATIONS

2.1 Field Staff

It is the responsibility of the field staff to conduct bedrock coring in a manner which is consistent with this SOP. Field staff will observe all activities pertaining to bedrock coring to ensure that the SOP is followed, and to record all pertinent data into a digital capture device, onto a boring log or into field log book. It is also the responsibility of field staff to indicate the specific targeted sampling depth or sampling interval to the drilling subcontractor. Field staff will also collect representative environmental or stratigraphic characterization samples once the sampling device has been retrieved and the sample is placed in the plastic sleeve. Additional sample collection responsibilities include labeling, handling, and storage of samples until further chain-of-custody procedures are implemented.

2.2 Drilling Subcontractor

It is the responsibility of the drilling subcontractor to provide the necessary tooling for obtaining bedrock core samples. This generally includes the sonic drilling rig and one or more core barrels in good operating condition, and other necessary equipment for borehole preparation and sampling. Equipment decontamination materials should also be provided by the subcontractor and should meet project specifications.

3.0 HEALTH AND SAFETY

The health and safety considerations for the work associated with this SOP, including both potential physical and chemical hazards, are addressed in the site specific *Health and Safety Plan (HASP)* (Enbridge, 2010). All work will be conducted in accordance with the HASP.

Boring completion may involve physical and/or chemical hazards associated with exposure to water, sediment, or materials in contact with either water or sediment. When sediment sampling is performed, adequate health and safety measures must be taken to protect field personnel. These measures are addressed in the project *HASP*.

4.0 INTERFERENCES

Potential interferences could result from cross-contamination between borehole locations. Minimization of the cross-contamination will occur through the use of clean sampling tools at each location, which will require decontamination of sampling equipment as per *SOP EN-105 – Decontamination of Field Equipment.*

5.0 EQUIPMENT & SUPPLIES

In addition to those materials provided by the subcontractor, the following equipment list contains materials which may be needed in carrying out the procedures contained in this SOP. Not all equipment listed below may be necessary for a specific activity. Additional equipment may be required, pending field conditions.

- Boring Logs or electronic data collected (such as Trimble Yuma® or equivalent),
- Core boxes and filler blocks,
- Folding rule or tape measure,
- Protractor and calculator,
- Health and safety equipment (as required by the *HASP*),
- Field project notebook and pen,
- Camera,
- Permanent marker (e.g. Sharpie®), and
- Munsell color chart or equivalent.

Sampling equipment which comes in direct contact with environmental samples during the sample collection process should be constructed of stainless steel, Teflon®, or glass, unless specified otherwise in this *Sampling and Analysis Plan (SAP)* (Enbridge, 2011a) or the *Quality Assurance Project Plan (QAPP)* (Enbridge, 2011b).

Other materials that may be required:

- Potable water supply,
- Rock hammer,
- Hand lens,
- Dilute hydrochloric acid,
- Plastic sheeting,
- Trash bags,
- Paper towels, and
- Appropriate containers and materials to manage investigation-derived waste (as specified in the work plan and this *SAP* and as required by *SOP EN-106 - Investigative Derived Waste Management*.

6.0 METHODS

6.1 General Method Description

Bedrock coring methods generally involve collection of bedrock cores by vibrating the core barrel directly into the bedrock ahead of the outer casing.

When the core barrel is retrieved from the borehole, the core is vibrated from the core barrel into a plastic sleeve to access the retrieved material. Field staff is then given access to the sample for whatever purpose is required.

6.2 Equipment Decontamination

Each core barrel must be decontaminated prior to its initial use and following collection of each core sample, especially if monitoring wells for analytical testing purposes are to be installed. If sampling for stratigraphic logging only is conducted, thorough decontamination between core samples may not be necessary although sufficient cleansing is necessary for the sampler to operate properly. Site-specific requirements for equipment decontamination are outlined in the Sampling and Analysis Plan. Equipment decontamination procedures are also outlined within *SOP EN-105 - Decontamination of Field Equipment*.

6.3 Sampling Procedure

6.3.1 Sample Tooling

- Decontaminate the core barrel and casings.
- Thread the core barrel onto the drill stem.

6.3.2 Sampling

- Advance outer casings and core barrel through any overburden materials per *SOP EN-303 - Subsurface Soil Sampling by Sonic Drilling Methods.*
- Seat outer casing into bedrock 5 to 10 feet depending upon competency of bedrock material.
- Lower the core barrel to the bottom of the borehole by adding the appropriate amount of drill stem.
- Advance the core barrel ahead of outer casing.

- Advance additional outer casing as subsurface conditions (fracturing, *etc.*) require to the terminal depth of the core barrel.
- Use the drilling rig to pull the core barrel from the borehole.

6.3.3 Sample Recovery

- Once the core barrel has been removed from the borehole, the bedrock core is removed from the barrel by vibrating the core barrel and placing the core into a plastic sleeve.
- The recovered core sample may now be viewed, logged, and removed from the plastic sleeve for disposal or storage in a core box.

6.3.4 Volatile Organic Compound (VOC) Screening

- The following procedure should be utilized for headspace analysis for volatile organic compounds (VOCs*):*
- *Create a clean works*pace using clean polyethylene sheeting.
- Put on clean gloves immediately before sampling.
- Decontaminate the field scale and calibrate it with the 10-gram weight provided. Use the scale and weigh an empty syringe. Write the weight of the empty syringe in your field notebook. Open the sonic core barrel and insert the open end of the syringe into a fresh face of undisturbed soil (if possible). The VOC sample may be collected from the sample location by inserting the plastic syringe tool directly into the soil
- Push the syringe into the soil and fill it to the point where you believe that you have 10 grams of soil (you may wish to practice filling and weighing the syringe with similar soil from the same sampling location prior to taking your actual sample in order to get an idea of how much soil is required for a 10-gram sample).
- Using your gloved index finger, thumb, or other instrument, push the soil deeper into the syringe. Note that any material (gloves, instruments, etc.) touching the sample must be decontaminated and clean. Attempt to obtain an area at the opening of the syringe clear of soil. This will assist you in minimizing the amount of contaminants that will adhere to the scale.
- Weigh the soil-filled syringe with the field scale and write the weight in your field notebook.

- Subtract the weight of the syringe from the total weight of syringe and soil (soil must weigh 10 grams +/- 1 gram tolerance for a 9- to 11-gram range, WITHOUT the weight of the syringe). If you do not have 10 +/- 1 grams of soil, you MUST repeat steps 4 through 6, above, until you have a total of 10 +/- 1 grams of soil. For most soils, the same volume of soil will yield approximately the same weight of soil. If you have too much soil, you must remove the excess soil from the syringe until you fall within the 9- to 11-gram range.
- Write the soil weight in your field notebook. You do not need to provide the weight of the sample to the Laboratory; they will reweigh the sample upon receipt.
- Remove the cap from the 40-ml vial.
- Insert the open end of the syringe into the vial, push the plunger, and discharge the soil.
- Place cap TIGHTLY on the 40-ml vial and gently shake it for ten seconds.
- Completely fill out the sample label on the 40-ml vial.

6.3.5 Sample Collection

- Core samples may be extracted from the plastic sleeve with a spoon or spatula. Then the sample should be placed directly into the required sample container. As the rock core may be solid it may be necessary to break the core into pieces small enough to fit into sample jars.
- Once filled, the sample container should be properly capped, cleaned and labeled. Sample chain-of-custody and preservation procedures should then be initiated.
- Perform equipment decontamination following collection of the sample.

6.4 Rock Core Description

The procedure for rock core description involves the visual and manual examination of core samples. Information required for proper core description include the following:

- Rock type,
- Color,
- Composition,
- Grain size/Texture,
- Hardness,

- Bedding/Foliation,
- Structure (Fractures and Joints) including Inclination, Fracture Density/Spacing, Roughness, and Filling,
- Solution and Void Conditions,
- Recovery, and
- Rock Quality Designation (RQD).

7.0 DATA & RECORDS MANAGEMENT

The data associated with bedrock coring by sonic drilling may be included in the following:

- Boring logs (example shown as *Figure 1* or equivalent),
- Field logbook,
- Rock Core photographs (both wet and dry) which include:
  - A view of the complete core box with a ruler for scale. Use of index cards, white boards or equivalent is recommended to indicate borehole number, core box number, top and bottom designation, and depth range in the photograph.
  - Close-up views of specific features (e.g. fractures, infillings, voids, etc.) with a scale and indication of borehole number and depth of feature,
- Electronic data collection (Trimble Yuma® or equivalent),
- Field Modification Forms (used prior to field work, when required), and
- Nonconformance Records (used after field work, when required).

The following SOPs describe the data collection and record management procedures that should be followed as part of the sample collection process:

- *SOP EN-101 Field Records,*
- *SOP EN-102 Chain-of-Custody Procedures,* and
- *SOP EN-103 Packaging and Shipment of Environmental Samples*.

See the referenced SOPs for additional details.

8.0 QUALITY ASSURANCE AND QUALITY CONTROL

Quality control / Quality assurance requirements are dependent on task specific sampling objectives. Field personnel should follow specific quality control / quality assurance guidelines as outlined in the QAPP and/or this SAP.

Quality Control (QC) samples collected via sonic drilling may include field duplicates, equipment and/or field blanks, trip blanks, and matrix spike/matrix spike duplicates (MS/MSD). See the QAPP for collection frequency and methods.

9.0 REFERENCES

Enbridge, 2011a. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Sampling and Analysis Plan (SAP). August 30, 2011.

Enbridge, 2011b. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Quality Assurance Project Plan (QAPP). August 19, 2011.

Enbridge, 2010. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Health and Safety Plan (HASP). August 2010.

SOP EN-101 – Field Records

SOP EN-102 – Chain of Custody Procedures

SOP EN-103 – Packaging and Shipment of Environmental Samples

SOP EN-105 – Decontamination of Field Equipment

SOP EN-106 – Investigative Derived Waste Management

SOP EN-303 - Subsurface Soil Sampling by Sonic Drilling Methods

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Figure 1 Typical Boring Log

Client:	***LOCATION ID:***
Site Location:	
Task:	
Date/Time Core Collected:	*Sheet: _____ of _____*
Date/Time Core Logged:	
Logged By:	*Settled Recovery:*
Top of Casing Observations:	
	Sample Time:

BORING COMPLETION DETAIL

Depth (ft)	Depth to Groundwater	U.S.C.S.	**MATERIALS: Color, CLASSIFICATION (USCS - ASTM D2488), moisture, plasticity, cohesiveness, sedimentary structure, secondary grain size, other.**	Sample ID	UV Light Observations		Depth (ft)
					Core	Pan	

NOTES:

Approved

Enbridge Line 6B MP 608

Marshall, MI Pipeline Release

Monitoring Well Construction and Installation – SOP EN-401

Prepared for Michigan Department of Environmental Quality

Enbridge Energy, Limited Partnership

Submitted: November 11, 2010

Approved: August 30, 2011

Approved

Approved

LIST OF ACRONYMS

Enbridge	Enbridge Energy, Limited Partnership
HASP	Health and Safety Plan
IDW	Investigation derived waste
Line 6B	The pipeline owned by Enbridge Energy, Limited Partnership that runs just south of Marshall, Michigan
MDEQ	Michigan Department of Environmental Quality
MDEQ	Michigan Department of Environmental Quality
OSHA	Occupational Safety and Health Administration
PVC	poly vinyl chloride
QAPP	Quality Assurance Project Plan
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedure

1.0 SCOPE & METHOD SUMMARY

This Standard Operating Procedure (SOP) describes the basic techniques and general considerations to be followed when installing groundwater monitoring wells. Monitoring wells may be installed to monitor the depth to groundwater, to measure aquifer properties, and to obtain samples of groundwater for chemical analysis.

Monitoring well construction and installation generally involves drilling a borehole using conventional drilling equipment, installing commercially available well construction and filter/sealing materials, and development of the well prior to sampling. This SOP covers well construction and installation methods only. Well development methods are covered under *SOP No. EN-402 - Monitoring Well Development*

This SOP is applicable to installation of single monitoring wells within a borehole. The construction and installation of nested, multilevel or other special well designs is not proposed in this *Sampling and Analysis Plan* (SAP) (Enbridge, 2011a), nor are the methods covered within this SOP.

It is expected that the procedures outlined in this SOP will be followed. Procedural modifications may be warranted depending on field conditions, equipment limitations, or limitations imposed by the procedure. Substantive modification to this SOP will be noted in work plans or on Field Modification Forms as appropriate and will be approved in advance by the Task Manager. Deviations from the SOP will be documented in the project records and in subsequent reports.

2.0 PERSONNEL QUALIFICATIONS

Well construction and installation requires a moderate degree of training and experience as numerous drilling situations may occur that will require field decisions to be made. It is recommended that inexperienced personnel be supervised for several well installations before working on their own. Geologists or personnel with geologic experience should supervise well installation.

It is the responsibility of the field personnel to be familiar with the procedures outlined in this SOP and to directly oversee the construction and installation of the monitoring well by the drilling subcontractor to ensure that well installation specifications are completed in accordance with this SOP. It is also the responsibility of the field personnel to be familiar with the procedures outlined within this SAP, the *Quality Assurance Project Plan* (QAPP) (Enbridge, 2011b), and the *Health and Safety Plan* (HASP) (Enbridge, 2010). Field personnel are also responsible to make sure that proper decontamination procedures are followed, as well as proper documentation in the field logbook or field forms or field computer is completed.

It will be the responsibility of the drilling subcontractor to provide a trained operator and the necessary equipment for well construction and installation. Well construction materials should be consistent with project requirements.

Monitoring well construction personnel who work on sites where hazardous waste materials may be present will be health and safety certified as specified by the *Occupational Safety and Health Administration* (OSHA) (29 CFR 1910.120(e)(3)(i)).

3.0 HEALTH AND SAFETY

The health and safety considerations for the work associated with this SOP, including both potential physical and chemical hazards, is addressed in the site specific HASP. All work will be conducted in accordance with the HASP.

4.0 INTERFERENCES

Potential interferences could result from cross-contamination between borehole locations. Minimization of the cross-contamination will occur through the use of clean sampling tools at each location, which will require decontamination of sampling equipment as per *SOP EN-105 – Decontamination of Field Equipment*.

Other potential interferences may be due to well materials or interactions between well materials and the formation. The process of installing a well necessarily disturbs the geologic formation. Wells will be developed appropriately as described in *SOP EN-402*. The wells will be allowed to stabilize a minimum of twenty-four hours after installation before development and an additional 24 hours after development before a well is sampled to allow stabilization of both well construction and geological material.

Cross-contamination may also result when surface water runoff or other materials enter the well from the ground surface. To minimize this, wells will be installed with stick-up casings where possible. Where such wells may be at risk of damage from traffic (i.e., near roadways), bumpers may be placed around the well to prevent them from being hit. Where flush-mount well completions are necessary, such as at locations preferred by property owners, appropriate steps will be taken to reduce the potential for infiltration into the well as described in the following sections.

5.0 EQUIPMENT & SUPPLIES

The following equipment list contains materials which may be needed in carrying out the procedures contained in this SOP. Not all equipment listed below may be necessary for a specific activity. Additional equipment may be required, pending field conditions.

5.1 Well Construction Materials

Well construction materials are usually provided by the drilling subcontractor. The wells will consist of commercially available flush-threaded, wire wrap (if requested) well screen and riser pipe constructed of poly vinyl chloride (PVC), or stainless steel. Typically these will be with a minimum 2-inch inside diameter, however, alternate diameter wells may be used.

5.2 Well Completion Materials

Well completion materials include silica sand, bentonite, cement, protective casings, J-plugs, and locks. Completion materials are generally provided by the drilling subcontractor.

5.3 Other Required Materials

- Monitoring Well Construction Diagrams and field logbook and pen,
- Potable water supply,
- Plastic sheeting,
- Trash bags,
- Paper towels,
- Water level meter,
- Self-adhesive well labels,
- Waterproof marker or paint (to label wells),
- Equipment decontamination supplies,
- Health and safety supplies (as required by the HASP),
- Appropriate containers and materials to manage investigation derived waste (IDW) (as specified in *SOP EN-106 Investigative Derived Waste*), including non-hazardous waste labels.

6.0 METHODS

6.1 General Preparation

6.1.1 Borehole Preparation

Standard drilling methods including, but not limited to, direct push, hollow stem auger and sonic drilling, should be used by the drilling subcontractor under the supervision of field personnel to achieve the desired drilling/well installation target depths. A hand auger may be used at shallow well locations not accessible by a drilling rig.

The typical diameter of the borehole (inside the auger) will be a minimum of 2-inches greater than the outside diameter of the well screen/ riser pipe used to construct the well. This is necessary so that sufficient annular space is available to install filter packs, bentonite seals, and grout seals. However, in limited situations, due to the potential need for direct drive monitoring wells, a smaller diameter annulus may limit the diameter of the filter pack. In some situations, for example pre-pack or “stab” wells, little to no filter pack may be used.

If the borehole is installed using hand auger techniques, a bucket auger will be used to install the boring to the proposed depth. If the soil conditions do not allow the boring to remain open, a 4- to 6-inch diameter casing may be driven to depth to keep soil from collapsing into the boring.

6.1.2 Well Material Decontamination

New well materials (well screen and riser pipe) generally arrive at the site boxed and sealed within plastic bags, so decontamination prior to use is not anticipated. Well materials should be inspected by the field personnel upon delivery to check cleanliness. If the well materials appear dirty, then they should be decontaminated prior to use. Well casing and riser may be decontaminated by steam-cleaning by the drilling subcontractor in accordance with *SOP EN 105 - .Decontamination of Field Equipment*. For smaller materials such as caps, they may be decontaminated using detergent and water in accordance with SOP EN-105.

6.2 Well Construction Procedure

6.2.1 Depth Measurement

Once the target drilling depth has been reached, the drilling subcontractor will measure the total open depth of the borehole with a weighted tape measure or equivalent. Adjustments of borehole depth can be made at this time by drilling further or installing a small amount of sand filter material to achieve the desired depth. The water table depth may also be checked with a water level indicator.

6.2.2 Well Construction

The well screen and riser pipe generally are assembled by hand as they are lowered into the borehole through the hollow-stem augers. Before the well screen is inserted into the borehole, an end cap will be placed on the screen and the full length of the slotted portion of the well screen as well as the un-slotted portion of the bottom of the screen and end cap should be measured with a measuring tape. These measurements should be recorded on the well construction diagram.

After the above measurements have been taken, the drilling subcontractor may begin assembling the well. As the assembled well is lowered, care should be taken to ensure that it is centered in the hole. The well should be temporarily capped or covered before filter sand and other annular materials are installed. The well should be set at the base of the borehole or set on a sand pack if the borehole is back filled to the target screen depth, and this should be confirmed by observation or measurement at the time of installation.

6.2.3 Filter Sand Installation

A natural collapse sand pack around the well screen may be used at select locations to aid in the migration of free phase oil through pre-wetted soil. Filter sand will be added to the annular space that does not collapse as described below. The drilling subcontractor should fill the annular space surrounding the screened section of the monitoring well to at least one foot above the top of the slotted portion of the screen, or as dictated by field conditions, with appropriately graded, clean sand or fine gravel. In general, the filter pack should not extend more than three feet above the top of the slotted portion of the screen to limit the thickness of the monitoring zone. If coarse filter materials are used, an additional 1-foot thick layer of fine sand should be placed immediately above the filter pack to prevent the infiltration of sealing components (bentonite or grout) into the filter pack. As the filter pack is placed, a weighted tape should be lowered into the annular space to verify the depth to the top of the layer. Depending upon depth, some time may be required for these materials to settle. If necessary, to eliminate possible bridging or creation of voids, placement of the sand pack may require the use of a tremie pipe. Tremie pipe sand pack installations are generally suggested for deep water table wells and for wells that are screened some distance beneath the water table. The augers/casing should be gradually removed from around the well as the sand pack is being installed.

6.2.4 Bentonite Seal Installation

A minimum 2-foot thick layer of bentonite pellets or slurry seal will be installed by the drilling subcontractor immediately above the well screen filter pack in all monitoring wells. The purpose of the seal is to provide a barrier to vertical flow of water in the annular space between the borehole and the well casing. Bentonite is used because it swells significantly upon contact with water. Pellets or chips generally can be installed in shallow boreholes by pouring them very slowly from the surface. If they are poured too quickly, they may bridge at some shallow, undesired depth. As an option, powdered bentonite may be mixed with water into a thick slurry and a tremie pipe can be used to inject the material at the desired depth. The bentonite materials will be hydrated by adding water to them after they have been placed in the borehole.

Under normal circumstances, extreme care will be undertaken to avoid advancement of boreholes through confining layers. If it becomes necessary to do so, however, an outer casing will be set in the confining layer and grouted in place. The integrity of the casing seal will be verified by evacuating the casing of all accumulated water and monitoring the casing interior for 24 hours to ensure no formation water enters the casing before proceeding with borehole advancement. If the confining layer is present above the well screen, an attempt will be made to set the bentonite seal at the same depth as the confining layer if possible to isolate the permeable zone from other portions of the borehole.

6.2.5 Annular Grout Seal Installation

The remainder of the annular space between the bentonite seal and the bottom of the concrete pad (typically 0 to 3 ft below grade), will be filled with grout or continued to be filled with bentonite chips or pellets. The grout seal should consist of a bentonite/cement mix with a ratio of bentonite to cement of between 1:5 and 1:20. The grout ratio should be chosen by the drilling subcontractor based on site conditions with a higher percentage of bentonite generally used for formations with higher porosity. The grout material will be mixed with water and placed into the borehole using a tremie pipe.

Bentonite chips or pellets utilized to backfill the annular space should be placed in the borehole and hydrated utilizing potable water taking care not to allow bridging of the material. Drill cuttings will not be used as backfill material.

6.2.6 Protective Casing/Concrete Pad Installation

The drilling subcontractor will cut the top of the well to the desired height and install a locking cap. Well casings are usually cut to be a certain height above ground surface (typically 2.5 to 3 feet) or are cut to be slightly below the ground surface, depending on the well location.

The drilling subcontractor will install a protective casing for wells finished above grade. A cement apron, flush to grade, will be installed to hold the protective casing (i.e., road boxes or stand up casing) in place. The surface of the concrete pad will be sloped so that drainage occurs away from the well. Flush-mount protective casings should be completed such that they are slightly mounded above the surrounding surface to prevent surface water from running over or ponding on top of the casing.

In areas subject to snowfall, flush-mount casings may have to be installed so that they are entirely flush with the ground surface as they may be damaged by snow plows.

Above-ground protective casings should also be vented or should have non-air tight caps. Road box installations should not be vented. Installation of additional guard pipes or bollard posts may be necessary around above-ground well completions in traffic areas. All new monitoring wells will include a locking well cap with locks that are keyed alike.

6.2.7 Well Numbering

The field personnel will number each well casing with an indelible marker or paint to identify the well. This is particularly important with nested or paired wells to distinguish between shallow and deep wells. The well should be labeled on both the outside of the protective casing and inside beneath the protective casing lid. Well identification numbers will be as specified in the work plan and this SAP.

6.2.8 Measuring Point Identification

Field personnel will mark the measuring point (normally on the north side of the well casing) from which water level measurements will be made at the upper edge of the well casing. PVC wells can be notched with a pocket knife or saw, or can be marked with a waterproof marker on the outside of the well casing with an arrow pointing to the measuring point location or a mark on the rim of the casing. The measuring point is the point that will require surveying during the well elevation survey task.

6.2.9 Well Measurements

Upon completion, the following well measurements should be taken by field personnel and recorded on the Monitoring Well Construction Diagram (form or digital capture):

- Depth to static water level if water level has stabilized (refer to *SOP EN-403 – Water Level Measurement in a Monitoring Well*),
- Total length of well measured from top-of-well casing (refer to *SOP EN-403 – Water Level Measurement in a Monitoring Well*),
- Height of well casing above/below ground surface,
- Height of protective casing above/below ground surface,
- Depth of bottom of protective casing below ground surface (may be estimated).

Well screen filter pack, bentonite seal, and annular seal thicknesses and depths should also be recorded on the *Monitoring Well Construction Diagram*.

6.2.10 Disposal of Drilling Wastes

Drill cuttings and other disposable materials must be properly contained, labeled, and disposed of. Site-specific requirements for collection and removal of these waste materials are outlined in the SOP or work plan. Containment of these materials should be performed by the drilling subcontractor.

6.2.11 Well Development

At some point after installation of a well and prior to use of the well for water level measurements or collection of water quality samples, development of the well shall be undertaken in accordance with *SOP EN-402 - Monitoring Well Development*.

6.2.12 Well Elevation Survey

At the completion of the well installation program, all monitoring wells will be surveyed to provide, at a minimum, the location (x and y coordinates), top-of-casing measuring point elevation for water level monitoring purposes, and ground surface elevation. All top-of-casing measurements will be made to within 0.01-feet and horizontal measurements to within 0.1 foot.

7.0 DATA AND RECORDS MANAGEMENT

All field information will be recorded in the field logbook or on a field collection form or in an electronic data collector (such as a Trimble Yuma® or equivalent) by field personnel. In addition, a field project logbook will be maintained detailing any problems or unusual conditions that may have occurred during the well drilling and installation process.

The records generated in this procedure will become part of the permanent record supporting the associated field work. All documentation will be retained in the project files following project completion.

8.0 QUALITY ASSURANCE AND QUALITY CONTROL

Field personnel should follow specific quality assurance guidelines as outlined in the QAPP and/or this SAP.

Certain quality control measures, as noted below, should be taken to ensure proper well completion.

- The borehole will be checked for total open depth, and extended by further drilling or shortened by backfilling, if necessary, before any well construction materials are placed.
- The water level will be checked during well installation to ensure that the positions of well screen, sand pack, and seal relative to water level conform to project requirements.
- The depth to the top of each layer of packing (i.e., sand, bentonite, and grout) will be verified and adjusted if necessary to conform to project requirements before the next layer is placed.
- If water or other drilling fluids (for example, to control heaving sands) have been introduced into the boring during drilling or well installation, samples of these fluids may be required for analysis of chemical constituents of interest.
- The volume of water or other drilling fluids introduced into the boring will be accurately measured by using a flow gauge or documenting the volume of water in the storage tank before and after the introduction of the fluids. These measurements will be recorded in the field log for future reference.

9.0 REFERENCES

Enbridge, 2011a. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Sampling and Analysis Plan (SAP). August 30, 2011.

Enbridge, 2011b. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Quality Assurance Project Plan (QAPP). August 19, 2011.

Enbridge, 2010. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Health and Safety Plan (HASP). August 2010.

SOP EN-105 – Decontamination of Field Equipment.

SOP EN-106 – Investigative Derived Waste

SOP EN-402 - Monitoring Well Development.

SOP EN-403 – Water Level Measurement in a Monitoring Well.

Approved

Enbridge Line 6B MP 608

Marshall, MI Pipeline Release

Monitoring Well Development – SOP EN-402

Prepared for Michigan Department of Environmental Quality

Enbridge Energy, Limited Partnership

Submitted: November 11, 2010

Approved: August 30, 2011

Approved

LIST OF ACRONYMS

HASP	Health and Safety Plan
IDW	Investigative Derived Waste
OSHA	Occupations Safety and Health Administration
QAPP	Quality Assurance Project Plan
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedure

1.0 SCOPE & METHOD SUMMARY

This Standard Operating Procedure (SOP) describes the basic techniques and general considerations to be followed for the development of newly installed monitoring wells and/or existing wells that may require redevelopment/rehabilitation.

Monitoring well development and/or redevelopment is necessary for several reasons:

- To restore hydraulic conductivity of the surrounding formations as they have likely been disturbed during the drilling process, or may have become partially plugged with silt,
- To remove drilling fluids (such as water and mud), when used, from the borehole and surrounding formations, and
- To remove residual fines from well filter materials and reduce turbidity of groundwater, thereby, reducing the chance of chemical alteration of groundwater samples caused by suspended sediments and providing representative groundwater samples.

Well development generally involves withdrawing water from a well using a pump, surge block or other suitable method such that, when completed effectively, the well is in good or restored hydraulic connection with the surrounding water bearing unit, produces minimal sediment, and is suitable for obtaining representative groundwater samples or for other testing purposes. Well development should be continued until the well produces water which is relatively free of sediments considering natural groundwater conditions and not be based solely on a specified volume of water removal.

It is expected that the procedures outlined in this SOP will be followed. Procedural modifications may be warranted depending on field conditions, equipment limitations, or limitations imposed by the procedure. Substantive modification to this SOP will be noted in task-specific work plans or on Field Modification Forms as appropriate and will be approved in advance by the Task Manager. Deviations from the SOP will be documented in the project records and in subsequent reports.

2.0 PERSONNEL QUALIFICATIONS

Well development procedures vary in complexity. It is recommended that initial development attempts be supervised by more experienced personnel.

Field personnel must be health and safety certified as specified by the *Occupational Safety and Health Administration (OSHA) (29 CFR 1910.120(e)(3)(i))* to work on sites where hazardous waste materials may be present.

It is the responsibility of the field personnel to be familiar with the procedures outlined within this SOP, quality assurance, and health and safety requirements outlined within this *Sampling and Analysis Plan* (SAP) (Enbridge, 2011a), the *Quality Assurance Project Plan* (QAPP) (Enbridge, 2011b), and the *Health and Safety Plan* (HASP) (Enbridge, 2010). Field personnel are responsible for completing proper well development, decontamination of equipment, as well as proper documentation in the field logbook, field forms, or electronic data collector such as the Trimble Yuma® or equivalent (if appropriate).

Approved

3.0 HEALTH AND SAFETY

The health and safety considerations for the work associated with this SOP, including both potential physical and chemical hazards, are addressed in the site specific Health and Safety Plan HASP. All work will be conducted in accordance with the HASP.

4.0 INTERFERENCES

Potential interferences could result from cross-contamination between monitoring wells. Minimization of cross-contamination will occur through the use of clean tools at each location, which will require decontamination of sampling equipment as per *SOP EN-105 – Decontamination of Field Equipment.*

The process of installing a well necessarily disturbs the geologic formation. Wells will be developed appropriately as described in this SOP. The wells will be allowed to stabilize a minimum of twenty-four hours, depending on grout type, after development before a well is sampled.

5.0 EQUIPMENT AND SUPPLIES

Well development can be performed using a variety of methods and equipment. The specific method chosen for development of any given well is governed by the purpose of the well, well diameter and materials, depth, accessibility, geologic conditions, static water level in the well, and type of constituents present, if any.

5.1 Pump Development

A pump is often necessary to remove large quantities of sediment-laden groundwater from a well after using the surge block. In some situations, the pump alone can be used to develop the well and remove the fines by over-pumping (pumping at a high rate). Because the purpose of well development is to remove suspended solids from a well and the surrounding filter pack, the pump must be capable of moving some solids without damage. The preferred pump is a submersible pump, which can be used in both shallow and deep groundwater situations. A centrifugal pump may be used in shallow wells, but will work only where the depth to static groundwater is less than approximately 25 feet. Pumping may not be successful in low-yielding aquifer materials or in wells with insufficient hydraulic head.

5.2 Bailer Purging

A bailer is used to purge sediment-laden water from wells after using other devices such as a surge block. In some situations, the bailer can be used to develop a well by bailing and surging, often accompanied with pumping when appropriate. A bailer can be used for purging in situations where the depth to static water is greater than 25 feet and/or where insufficient hydraulic head is available for use of other development methods.

5.3 Surge Block Development

Surge blocks are commercially available for use with Waterra-type (or equivalent) pumping systems or may be manufactured using a "plunger" attached to a rod or pipe of sufficient length to reach the bottom of the well.

5.4 Other Materials

The following equipment list contains materials which may be needed in carrying out the procedures contained in this SOP. Not all equipment listed below may be necessary for a specific activity. Additional equipment may be required, pending field conditions.

- Well Development Records, and/or field logbook and pen, and/or electronic data collector,
- Boring and well construction logs (if available),
- Plastic sheeting,
- Buckets,
- Paper towels,
- Trash bags,
- Power source (generator or 12-volt marine battery),
- Water level meter and/or well depth measurement device,
- Equipment decontamination supplies (as required by *SOP EN-105 – Decontamination of Field Equipment.*),
- Health and safety supplies (as required by the HASP), and
- Appropriate containers, labels and materials to manage investigation-derived waste (IDW) (as specified in this SAP and as required by *SOP EN-106 – Investigative Derived Waste Management*).

6.0 METHODS

6.1 General Preparation

Develop wells as soon as possible after construction, but no sooner than 24 hours after placing the annular seal. If bentonite chips are used as an annular seal, development can occur after 24 hours. If grout or neat cement is used, the time before well development can increase to 48 hours. The main concern is that the method being used for development does not interfere with allowing the grout to set. Develop the entire vertical screened interval using surge blocks, bailers, pumps, or other equipment which frequently reverses the flow of water through the well screen and prevents bridging of formation or filter particles.

Well construction logs should be reviewed to determine well construction characteristics. Formation characteristics should also be determined from review of available boring logs.

Provisions should be in place for collection and management of IDW relating to well development such as I development water and miscellaneous expendable materials generated during the development process. The collection of IDW in drums or tanks may be required depending on project-specific requirements.

The water level and well depth should be measured in accordance with *SOP EN-403 – Water Level Measurement in a Monitoring Well* and written on the field documentation (field log book, well development record, and/or electronic data collector). This information is used to calculate the volume of standing water (i.e., the well volume) within the well.

The quantity of drilling fluids such as mud or water, if used during the drilling and well installation process, should be recorded and a minimum of 3 times the volume of fluid introduced during drilling should be removed during the well development procedure. If the quantity of added fluid is not known or cannot be reasonably estimated, removal of a minimum of 10 well volumes of water is recommended during the development procedure.

6.2 Development Procedure

6.2.1 Development Method Selection

The construction details of each well shall be used to define the most suitable method of well development. Some consideration should be given to the potential concentrations of constituents in each well as this will impact IDW containment requirements.

The criteria for selecting a well development method include well diameter, total well depth, static water depth, screen length, the likelihood and potential concentrations of constituents, and characteristics of the geologic formation adjacent to the screened interval.

The limitations, if any, of a specific procedure are discussed within each of the following procedures.

6.2.2 Turbidity

Turbidity of development water will be observed during well development to monitor the progress of development. Visual observations of turbidity, such as silty or cloudy water, should be noted in the field documentation.

6.2.3 Bailer Procedure

Bailers shall preferably not be used for well development but may be used in combination with a surge block to remove sediment-laden water from the well.

- When using a bailer to purge well water; select the appropriate bailer, then tie a length of bailer cord onto the end of the bailer.
- Lower the bailer into the screened interval of the monitoring well. Sediment , if present, will generally accumulate within the lower portions of the well screen.
- The bailer may be raised and lowered repeatedly in the screened interval to further simulate the action of a surge block and pull silt through the well screen.
- Remove the bailer from the well and empty it into the appropriate storage container.
- Continue surging/bailing the well until relatively sediment-free water is obtained considering background aquifer conditions. If moderate to heavy sedimentation is still present, the surge block procedure should be repeated and followed again with bailing. If it is not possible to further reduce the turbidity, the well will be purged a minimum of 10 minutes after this determination.
- Visually check turbidity periodically.

6.2.4 Surge Block Procedure

A surge block effectively develops most monitoring wells.

- Insert the surge block into the well and lower it slowly to the level of static water. Start the surge action slowly and gently above the well screen using the water column to transmit the surge action to the screened interval. A slow initial surging, using plunger strokes of approximately 3 feet, will allow material that is blocking the screen to separate and become suspended.
- After 5 to 10 plunger strokes, sediment-laden water will be removed from the well using a pump integrated with the surge block, or removing the surge block to purge the well using a pump or bailer. Discharge the purged water into the appropriate storage container.
- Repeat the process. As development continues, slowly increase the depth of surging to the bottom of the well screen. For monitoring wells with long screens (greater than 10 feet) surging should be undertaken along the entire screen length in short intervals (3 feet) at a time. Continue this cycle of surging and purging until the water yielded by the well is free of visible suspended material. If it is not possible to further reduce the turbidity the well will be purged a minimum of 10 minutes after this determination.
- Visually check turbidity periodically.

6.2.5 Pump Procedure

Well development using only a pump is most effective in monitoring wells that will yield water continuously. Effective development cannot be accomplished if the pump has to be shut off to allow the well to recharge.

- When using a submersible pump or surface pump, set the intake of the pump or intake line in the center of the screened interval of the monitoring well.
- Pump a minimum of three well volumes of water from the well and raise and lower the pump line through the screened interval to remove any silt/laden water.
- Continue pumping water from the well until sediment-free water is obtained. This method may be combined with the manual surge block method if well yield is not rapid enough to extract silt from the surrounding formations. If it is not possible to further reduce the turbidity, the well will be purged a minimum of 10 minutes after this determination
- Visually check turbidity periodically.

6.3 Equipment Decontamination

All equipment that comes into contact with groundwater (e.g., surge block) will be decontaminated in accordance with *SOP EN-105 – Decontamination of Field Equipment* before moving to the next location. If a disposable bailer is used, it should be properly discarded and disposed of in accordance with procedures for managing IDW outlined in this SAP.

Approved

7.0 DATA AND RECORDS MANAGEMENT

All field information will be recorded in the field logbook, on a field collection form, or with an electronic data collector by field personnel. This information will include, at a minimum, well and sample designation, pre-sampling water level elevation, volume of purge water removed from each well, pre and post purge sampling parameters. In addition, the field project logbook will include notes regarding any problems or unusual conditions that may have occurred during the development process.

The records generated in this procedure will become part of the permanent record supporting the associated field work. All documentation will be retained in the project files following project completion.

8.0 QUALITY ASSURANCE AND QUALITY CONTROL

Field personnel should follow specific quality assurance guidelines as outlined in the QAPP and/or this SAP.

A well will have been successfully developed when one or more of the following criteria are met:

- The sediment load in the well has been eliminated or greatly reduced based upon visual observation of turbidity or field measurement of turbidity.
- If it is not possible to further reduce the visible turbidity, the well will be purged a minimum of 10 minutes after this determination.

9.0 REFERENCES

Enbridge, 2011a. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Sampling and Analysis Plan (SAP). August 30, 2011.

Enbridge, 2011b. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Quality Assurance Project Plan (QAPP). August 19, 2011.

Enbridge, 2010. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Health and Safety Plan (HASP). August 2010.

SOP EN-105 – Decontamination of Field Equipment.

SOP EN-106 –Investigative Derived Waste Management.

SOP EN-403 – Water Level Measurement in a Monitoring Well.

Approved

Enbridge Line 6B MP 608
Marshall, MI Pipeline Release

Water Level Measurement in a Monitoring Well SOP EN-403

Prepared for Michigan Department of Environmental Quality

Enbridge Energy, Limited Partnership

Submitted: November 11, 2010

Approved: August 30, 2011

Approved

Approved

LIST OF ACRONYMS

CFR	Code of Federal Regulations
Enbridge	Enbridge Energy, Limited Partnership
HASP	Health and Safety Plan
Line 6B	The pipeline owned by Enbridge Energy, Limited Partnership that runs just south of Marshall, Michigan
LNAPL	Light Non-Aqueous Phase Liquid
OSHA	Occupational Safety and Health Administration
QAPP	Quality Assurance Project Plan
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedure

1.0 SCOPE & METHOD SUMMARY

This Standard Operation Procedure (SOP) describes the methods to be used for measuring depth to groundwater and light non-aqueous phase liquid (LNAPL) levels and total depth of groundwater monitoring wells and piezometers. Similar procedures will also be used to measure the depth to water in surface water bodies from fixed structures such as bridges or culverts.

Water and LNAPL level and well depth measurements collected from monitoring wells or piezometers are used to assess:

- The horizontal hydraulic gradient and the direction of groundwater flow,
- The vertical hydraulic gradient, if well nests are used (i.e., the direction of groundwater flow in the vertical plane),
- The calibration of a numerical groundwater flow model,
- The thickness of LNAPL in a monitoring well, and
- Surface Water Elevation.

This information, when combined with other location-specific information, such as hydraulic conductivity or transmissivity, may be used to estimate the rate of constituent movement, etc. Total well depth measurements are also collected as an indicator of siltation within the well column and to calculate well volumes if necessary.

Measurements will involve measuring the depth to LNAPL, depth to water or total well depth to the nearest 0.01 foot using an electronic probe (water level or product level meter). The depths within wells will be measured from the top of the inner casing at the surveyed elevation point as marked on the top of the inner casing. Distance to surface water will be measured from a mark placed on the fixed structure (e.g., bridge, culvert) by the surveyor.

It is expected that the procedures outlined in this SOP will be followed. Procedural modifications may be warranted depending on field conditions, equipment limitations, or limitations imposed by the procedure. Substantive modification to this SOP will be noted in task-specific work plans or on Field Modification Forms as appropriate and will be approved in advance by the Task Manager. Deviations from the SOP will be documented in the project records and in subsequent reports.

2.0 PERSONNEL QUALIFICATIONS

Collecting water and LNAPL level measurements is a relatively simple procedure requiring minimal training and a relatively small amount of equipment.

Field personnel must be health and safety certified as specified by the Occupational Safety and Health Administration (OSHA) (29 CFR 1910.120(e)(3)(i)) to work on sites where hazardous waste materials may be present.

It is the responsibility of the field sampling personnel to be familiar with the sampling procedures outlined within this SOP, and with specific sampling, quality assurance, and health and safety requirements outlined in this *Sampling and Analysis Plan (SAP)* (Enbridge, 2011a), the *Quality Assurance Project Plan (QAPP)* (Enbridge, 2011b), and the *Health and Safety Plan (HASP)* (Enbridge, 2010). Field personnel are responsible for the proper use, maintenance, and decontamination of all equipment used for obtaining water and LNAPL level measurements, as well as proper documentation in the field logbook, field forms, or electronic documentation (if appropriate).

3.0 HEALTH AND SAFETY

The health and safety considerations for the work associated with this SOP, including both potential physical and chemical hazards, is addressed in the site specific HASP. All work will be conducted in accordance with the HASP.

4.0 INTERFERENCES

Potential interferences could result in inaccurate readings if the sensor on the water or product level meter is dirty, or if the cable cannot be kept vertically upright (for example, from a bridge in the wind). Care shall be taken to keep the probe clean. If wells are not installed plumb, the probe may rest against the side of the well, which may be wet. Care shall be taken in measuring water or LNAPL levels to reduce these interferences. If there is any concern that a particular reading may not be accurate, this shall be noted in the field documentation.

Pressure build up in a sealed flush mounted well may also cause initial water levels to be different than actual static water levels. In areas with low permeability and where sealed well caps (not vented) have been installed, wells should be left uncapped for a period ranging from a minute to ten minutes prior to measuring the water levels. However, one to ten minutes may not be sufficient for water levels to stabilize to atmospheric pressure in some wells and may require a number of readings over time to establish that equilibration and stabilization have been achieved. If any indication of gas build up in the well is observed upon removing the cap, such as a sound of air rushing into or out of the well, then a resting period should be allowed for the water level in the well to equilibrate with atmospheric pressure.

5.0 EQUIPMENT & SUPPLIES

The following equipment list contains materials which may be needed in carrying out the procedures contained in this SOP. Not all equipment listed below may be necessary for a specific activity. Additional equipment may be required, depending on field conditions.

5.1 Electronic Water Level Meter

Electronic water and product level meters consist of a spool of small-diameter cable (or tape) with a weighted probe attached to the end. When the probe comes in contact with the LNAPL and/or water, an electrical circuit is closed, and a light and/or buzzer within the spool will signal the contact. A different tone or light is used to indicate LNAPL and water. The probe shall be tested at the start of the field program to ensure proper operation.

5.2 Other Materials that may be Required

- Health and safety supplies (as required by the HASP),
- Equipment decontamination materials (as required by *SOP EN-105, Decontamination of Field Equipment*),
- Water and LNAPL level field form or electronic data collector such as the Trimble Yuma® or equivalent (if applicable),
- Well construction records and previous monitoring data, and
- Field project logbook and pen.

6.0 METHODS

6.1 General Preparation

6.2 Water and LNAPL Level/Well Depth Measurement

The water and LNAPL level should be measured with a water or product level meter and written in the field logbook, field form, and/or electronic data collector. If the well depth is not known it should be measured with a water or product level meter and recorded in the field logbook, field form, and/or electronic data collector. This information is used to calculate groundwater elevations. All data will be maintained in the project files.

6.3 Equipment Decontamination

All equipment should be decontaminated prior to use and between well locations in accordance with SOP EN-105.

6.4 Measurement Procedures

At each location (well, piezometer, etc.), determine the location of the surveyed elevation mark. For wells, general markings include either a notch in the riser pipe or a permanent ink (generally black ink) mark on the riser pipe. For monitoring surface water levels, there may be a painted mark on an existing structure or the reference point must be known if not painted. All groundwater and LNAPL level measurements should be collected prior to any ground water sampling.

To obtain a water and/or LNAPL level measurement, lower the probe of a water or product level meter down into the water or LNAPL until the audible sound of the unit is detected or the light on an electronic sounder illuminates. The light and/or sound will change as the LNAPL probe passes through the LNAPL and enters the water. In wells and piezometers, the probe shall be lowered slowly into the well to avoid disruption of formation water and creation of turbulent surface water within the well. At this time, the precise measurement should be determined (to nearest 0.01 feet) by repeatedly raising and lowering the tape to converge on the exact measurement. Obtain the reading from the surveyed elevation mark. When measuring water levels in wells installed in low permeability material, additional readings should be collected over

10 to 30 minutes to establish that equilibration has been achieved. This will be site or well dependent.

Record the water and LNAPL level measurements as well as the location identification number, date, time, and weather conditions in the field logbook, field form and/or electronic data collector.

To measure the total depth of a well, lower the probe (turn down signal as appropriate) slowly to the bottom of the well. The depth may be difficult to determine for wells with “soft” or silty bottoms. It may be helpful to lower the probe until there is slack in the tape, and gently pull up until it feels as if there is a weight at the end of the tape. Observe the measurement (to the nearest 0.01 foot) of the tape against the surveyed elevation mark.

Record the total well depth in the field logbook, field form, and/or electronic data collector.

The meter will be decontaminated in accordance with SOP EN-105. Generally, only that portion of the tape that enters the LNAPL and water needs to be decontaminated. It is important that the measuring tape is never allowed to become kinked.

7.0 DATA & RECORDS MANAGEMENT

All field information will be recorded in the field logbook, on a field collection form, or in an electronic data collector such as the Trimble Yuma® or equivalent, by field personnel. Any problems or unusual conditions that may have occurred during the measurement process will be noted.

The records generated in this procedure will become part of the permanent record supporting the associated field work. All documentation will be retained in the project files following project completion.

8.0 QUALITY ASSURANCE & QUALITY CONTROL

Field personnel will follow specific quality assurance guidelines as outlined in the QAPP and/or this SAP. Where measured depths are not consistent with well records or previously measurements, the depths should be re-measured and verified.

9.0 REFERENCES

Enbridge, 2011a. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Sampling and Analysis Plan (SAP). August 30, 2011.

Enbridge, 2011b. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Quality Assurance Project Plan (QAPP). August 19, 2011.

Enbridge, 2010. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Health and Safety Plan (HASP). August 2010.

SOP EN-105 – Decontamination of Field Equipment.

Approved

Enbridge Line 6B MP 608

Marshall, MI Pipeline Release

Low Flow Groundwater Sampling– SOP EN-404

Prepared for Michigan Department of Environmental Quality

Enbridge Energy, Limited Partnership

Submitted: November 11, 2010

Approved: August 30, 2011

Approved

LIST OF ACRONYMS

C	Celsius
CFR	Code of Federal Regulations
DO	dissolved oxygen
GFI	ground fault interrupt
HASP	Health and Safety Plan
L/min	liters per minute
MS/MSD	Matrix Spike/Matrix Spike Duplicate
NTU	Nephelometric Turbidity Unit
OSHA	Occupations Safety and Health Administration
ORP	Oxidation Reduction Potential
QAPP	Quality Assurance Project Plan
QC	Quality Control
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedure
TOC	Top of Well Casing

1.0 SCOPE & METHOD SUMMARY

This Standard Operation Procedure (SOP) describes the method for collecting valid and representative samples of groundwater from monitoring wells. This SOP is written such that consideration of different sampling equipment may be used in different instances for collecting representative groundwater samples. The procedures presented in this SOP are taken from the United States Environmental Protection Agency's documents; *Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures* (U.S. EPA, 1996) and *Low Stress (low flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells* (U.S. EPA, 2010).

Groundwater sample collection generally involves purging the water that is non-representative of the formation water from a well prior to sample collection. Water quality indicator parameters are monitored until all parameters have stabilized for three successive readings. After the indicator parameters have stabilized, groundwater samples are then collected into the appropriate bottle or containers.

It is expected that the procedures outlined in this SOP will be followed. Procedural modifications may be warranted depending on field conditions, equipment limitations, or limitations imposed by the procedure. Substantive modification to this SOP will be noted in task-specific work plans or on Field Modification Forms as appropriate and will be approved in advance by the Task Manager. Deviations from the SOP will be documented in the project records and in subsequent reports.

2.0 PERSONNEL QUALIFICATIONS

Groundwater sample collection is a relatively involved procedure requiring formal training and a variety of equipment. It is recommended that initial sampling of groundwater wells be supervised by more experienced personnel.

Field personnel must be health and safety certified as specified by the Occupational Safety and Health Administration (OSHA) (29 CFR 1910.120(e)(3)(i)) to work on sites where hazardous materials may be present.

It is the responsibility of the field sampling personnel to be familiar with the sampling procedures outlined within this SOP, and with specific sampling, quality assurance, and health and safety requirements outlined in this *Sampling and Analysis* Plan (SAP) (Enbridge, 2011a), the *Quality Assurance Project Plan (QAPP)* (Enbridge, 2011b), and the *Health and Safety Plan (HASP)* (Enbridge, 2010). Field personnel are responsible for the proper use, maintenance, and decontamination of all equipment used for obtaining water level measurements, as well as proper documentation in the field logbook, field forms, or electronic documentation (as appropriate).

Approved

3.0 HEALTH AND SAFETY

The health and safety considerations for the work associated with this SOP, including both potential physical and chemical hazards, is addressed in the site specific HASP. All work will be conducted in accordance with the HASP.

4.0 INTERFERENCES

Potential interferences could result from cross-contamination between samples and sample locations. Minimization of cross-contamination will occur through the use of clean or new sampling tools at each location, which will require decontamination of sampling equipment following *SOP EN-105 – Decontamination of Field Equipment*.

Potential interferences could result from the power source (e.g. generator). Minimization of contamination will occur through locating the power source a sufficient distance away from the well and sampling equipment and handling the power source with dedicated or disposable gloves.

5.0 EQUIPMENT & SUPPLIES

The following equipment list contains materials which may be needed in carrying out the procedures contained in this SOP. Not all equipment listed below may be necessary for a specific activity. Additional equipment may be required, pending field conditions.

- Well keys for secured wells;
- Road box (flush mount) keys;
- Purging and Sampling Pumps;
  - Peristaltic pump,
  - Submersible pump, and
  - Bladder pumps & extra bladders.
- Field Instruments;
  - Individual or multi-parameter meter(s) to measure temperature, pH, specific conductance, dissolved oxygen (DO), oxidation reduction potential (ORP), and turbidity, and
  - Water level meter.
- Tubing (Silicone and polyethylene (or as required for sampling, air supply, etc.));
- Previous Sample Collection Records or Electronic Data Collector such as Trimble Yuma® or equivalent;
- Disposable nitrile gloves
- Sample kit (i.e., bottles, labels, preservatives, cooler, ice);
- Filtration equipment (if necessary);
- Sample Chain of Custody forms (as required by *SOP EN-102 – Chain of Custody Procedures*);
- Sample packaging and shipping supplies (as required by *SOP EN-103 – Packaging and Shipment of Environmental Samples*);
- Waterproof marker or paint;
- Distilled or deionized water and dispenser bottles;

- Flow measurement cup or bucket;
- Buckets with lids;
- Instrument calibration solutions;
- Power source (generator or 12-volt marine battery) and extension cords with ground fault interrupt (GFI) protection;
- Air compressor or compressed gas for bladder pump;
- Paper towels;
- Plastic sheeting;
- Trash bags;
- Ziplock-style bags;
- Equipment decontamination supplies (as required by *SOP EN-105 – Decontamination of Field Equipment*);
- Health and safety supplies (as required by the HASP); and
- Field project logbook and pen.

6.0 METHODS

6.1 Instrument Calibration

Field instruments will be calibrated according to the requirements of the QAPP and manufacturer's specifications for each piece of equipment (e.g., SOP EN-502 - *Water Quality Instrumentation*). Calibration records shall be recorded in the field logbook, appropriate field form, or electronic data collector.

6.2 Well Security and Condition

At each monitoring well location, observe the conditions of the well and surrounding area. Any issues with the following information should be noted on the groundwater sample collection record, field logbook, or electronic data collector

- Condition of the well's identification marker;
- Condition of the well lock and associated locking cap;
- Integrity of the well - protective outer casing, obstructions or kinks in the well casing, presence of water in the annular space, and the top of the interior casing; and
- Condition of the general area surrounding the well.

6.3 Measuring Point Determination

Identify an existing measuring point in accordance with *SOP EN-403 – Water Level Measurement in a Monitoring Well*. Generally, the measuring point is referenced from the top of the well casing (TOC), not the protective casing. If no measuring point exists, a measuring point should be established on the north side of the well casing, clearly marked, and identified on field documentation (i.e., groundwater sample collection record, field logbook, or electronic data collector). The same measuring point should be used for subsequent sampling events.

6.3.1 Water Level Measurement

Water level measurements should be collected in accordance with *SOP EN-403 – Water Level Measurements*. <u>DO NOT</u> collect total well depth until sample has been collected. Taking a total depth measurement will disturb sediments that have settled to the bottom of the well. This most likely will create high turbidity readings. The water level measurement should be entered on appropriate field documentation.

6.4 Well Purging Methods and Procedures

6.4.1 Objectives

Prior to sample collection, purging must be performed for all groundwater monitoring wells to remove water from within the casing and filter pack to ensure that a representative groundwater sample is obtained.

All groundwater samples will be collected using low flow (low-stress) purging and sampling procedures. The low-flow method emphasizes the need to minimize water level drawdown and low groundwater pumping rates to collect samples with minimal alterations to groundwater chemistry.

During well purging, the water level will be measured with a water level meter in accordance with *SOP EN-403 – Water Level Measurement.* Water level drawdown and flow rate will be recorded on field documentation. A final purging rate will be selected that does not exceed 0.5 liters per minute (L/min) (typically between 0.1 L/min and 0.3 L/min), and results in little to no drawdown, ideally less than 0.3 feet.

The general types of non-dedicated equipment used for well purging include surface pumps and down-well pumps. Peristaltic pumps will generally be used unless the depth to water is too great, in which case submersible pumps will be used.

Purge water will be pumped through a flow-through cell and the following parameters will be measured: pH, specific conductivity, temperature, DO, ORP, and turbidity. These parameters will be measured with a water quality meter, calibrated according to the manufacturer's specifications (see *SOP EN-502 - Water Quality Instrumentation*). Turbidity may also be measured separately with a nephelometer, also calibrated to the manufacturer's specifications. A round of parameter measurements will be recorded approximately 10 minutes after the flow-through cell is full, and then every 3 to 5 minutes thereafter, until parameter values have stabilized.

Purging is considered complete and sampling may begin when all parameter values have stabilized and turbidity is below 10 Nephelometric Turbidity Units (NTU). Stabilization is considered to be achieved when three consecutive readings, taken at 3- to 5-minute intervals, are within the following limits:

- Turbidity : less than 10 NTU or ± 10%
- DO : ± 10%
- Specific Conductance : ± 3%
- Temperature : ± 3% or less than 0.5 degrees C
- pH : ± 0.1 standard units
- ORP : ± 10 millivolts

Every effort will be made to lower the turbidity to less than 10 NTU before sampling. If the turbidity cannot be reduced to below 10 NTU, the pumping rate will be reduced for 10 minutes. If turbidity still cannot be reduced below 10 NTU, samples may be collected if all other parameters are stable and the turbidity is stable (i.e. not improving). The condition will be noted on the field documentation. During hot and cold weather sampling, short tubing lengths should be utilized to avoid temperature changes and freezing of the tubing – if the sample temperature does not stabilize as the water flows through tubing exposed to ambient temperatures, this should be noted in the field notes.

If after one hour of purging, stabilization of parameters is not achieved, a sample will be collected and recorded in the field notes.

All purge water will be containerized and disposed per the project plan.

If a well purges dry, a groundwater sample will be collected when sufficient water has recharged the well. The condition will be noted on the field documentation.

6.5 Surface Pumps

6.5.1 General

Well purging using pumps located at the ground surface can be performed with a peristaltic pump if the water level in the well is within approximately 20 feet of the top of the well.

Peristaltic pumps provide a low rate of flow typically in the range of 0.075-0.750 L/min and a minimal disturbance of the water column.

6.5.2 Peristaltic Pump Procedure

Attach a new sample tube set-up to the peristaltic pump. Silicone tubing must be used through the pump head and must meet the pump head specifications. A second type of tubing (e.g., polyethylene) will be attached to the silicone tubing for use as the suction and discharge lines.

Measure the length of the suction line and lower it down the monitoring well until the end is located at the midpoint of the saturated screen and at least 2 feet above the bottom of the well to preclude excess turbidity from the bottom of the well. Start the pump and direct the discharge into a graduated bucket. Adjust the pumping rate with the speed control knob so that a smooth flowing discharge is attained.

Measure the pumping rate by recording the time required to fill a flow measurement cup or bucket. The pumping shall be monitored to assure continuous discharge. If drawdown causes the discharge to stop, the suction line will be lowered very slowly further down into the well until pumping restarts. The pumping rate will be adjusted so that drawdown is stabilized, ideally at a level less than 0.3 feet.

6.6 Down-Well Pumps

6.6.1 General

Groundwater withdrawal using non-dedicated down-well pumps may be performed with a submersible pump or a bladder pump.

Electric submersible pumps provide an effective means for well purging and in some cases sample collection. Submersible pumps are particularly useful for situations where the depth to water table is greater than 20 feet and where the depth or diameter of the well requires that a large purge volume be removed before sample collection.

A commonly available submersible pump, the Grundfos Redi-Flo2™ pump (or equivalent), is suited for operation in 2-inch or larger internal diameter wells. Pumping rates are adjusted to low-flow levels by adjusting the current to the pump motor rather than using a flow valve.

Bladder pumps may also be used as an alternative method to using the submersible pump.. Bladder pumps usually consist of a stainless steel pump housing with an internal Teflon® or polyethylene bladder. Discharge and air line tubing is connected to the bladder pump to the air compressor and control unit. The pump is operated by lowering it into the water column to the midpoint of the well screen, then pulsing air into the bladder from the air compressor and pump controller unit. Pumps and controllers are often not interchangeable between manufacturers; therefore, it is usually necessary to have both items provided by the same manufacturer. Pump bladders are generally field-serviceable and replaceable.

A check of well condition shall be completed prior to inserting any down-well pump if the well has not been sampled for some time or if groundwater quality conditions are not known. The well condition check should include a check of the casing to determine if there are any obstructions.

6.6.2 Electric Submersible Pump Procedure

Slowly lower the submersible pump with attached discharge line into the monitoring well taking notice of any roughness or restriction within the well riser pipe. The inlet of the pump should be placed at the midpoint of the saturated monitoring well screen. The power cord should be attached to the discharge line with an inert material (i.e., zip-ties) to prevent the power cord from getting stuck between the pump, discharge line, and the well casing. Secure the discharge line and power cord to the well casing, using tape or a clamp, taking care not to crimp or cut either the discharge line or power cord.

Connect the power cord to the power source (i.e., rechargeable battery pack, auto battery, or generator) and turn the pump on. Voltage and amperage meter readings on the pump controller (if provided) should be monitored closely during purging. The operations manual for the specific pump used should be reviewed regarding changes in voltage/amperage and the potential impacts on pump integrity. The pumping rate will be adjusted so that drawdown is stabilized, ideally at a level less than 0.3 feet.

6.6.3 Bladder Pump Procedure

As an alternative method to the submersible pump, bladder pumps may be used. To operate the bladder pump system, the pump and discharge line should be lowered into the well until the inlet of the pump is at the midpoint of the saturated monitoring well screen. Secure the discharge and power lines to the well casing with a clamp. The air compressor should then be turned on to activate pumping. The pump controller is used to vary the discharge rate to the required flow. The pumping rate will be adjusted so that drawdown is stabilized, ideally at a level less than 0.3 feet.

6.7 Sample Collection Methods and Procedures

6.7.1 Objectives

Groundwater samples can be collected using similar methods employed for purging. In most cases during sampling, groundwater will be transferred to the appropriate containers directly from the discharge source. It is important that the tubing from the pump to the flow-through cell be disconnected prior to sample collection. During transfer, discharge tubing and other equipment shall not contact the inside of the sample containers.

Groundwater samples that may require filtration (if specified in the work plan), will be filtered in the field at the wellhead using a 0.45-micron, in-line filter.

6.7.2 Surface Pumps

Using the methods and procedures described in Section 6.5, groundwater samples will be collected from the peristaltic pump. Sample bottles shall be filled directly from the pump's discharge line (after tubing has been disconnected from the flow-through cell) and care shall be taken to keep the discharge tube from contacting the sample container.

6.7.3 Down-Well Pumps

Using the pump methods described in Section 6.6, groundwater samples should be collected from either the electric submersible or bladder pump directly from the discharge line (after tubing has been disconnected from the flow-through cell). Sample bottles will be filled directly from the discharge line of the pump.

6.8 Sample Handling and Preservation

- Cap and label the container. .
- Place the sample containers into a cooler and maintain on ice.
- Complete sample chain of custody and other documentation per *SOP EN-102 – Chain of Custody Procedures*.
- Package the samples for shipment to the laboratory per *SOP EN-103 – Packaging and Shipment of Environmental Samples*.

6.9 Equipment Decontamination

All equipment that comes into contact with groundwater (e.g., submersible pumps) will be decontaminated in accordance with *SOP EN-105 – Decontamination of Equipment* protocol before moving to the next location. Dedicated or disposable equipment will not be decontaminated.

7.0 DATA & RECORDS MANAGEMENT

Specific information regarding sample collection should be documented in several areas: the sample Chain of Custody Record; sample collection record, field logbook, or electronic data collector; and sample labels or tags. Additional information regarding each form of documentation is presented in the following paragraphs.

7.1 Sample Chain of Custody Record

This standard form requires input of specific information regarding each collected sample for laboratory analytical purposes, as specified in SOP EN-102.

7.2 Sample Collection Record or Electronic Data Collector

The sample collection record requires input of specific information regarding the collection of each individual sample including sample identification, water quality parameters, collection method, and containers/preservation requirements. An electronic data collector such as a Trimble Yuma® may be used in place of or in addition to the sample collection record.

7.3 Field Logbook

The logbook should be dedicated to the project and should be used by field personnel to maintain a general log of activities throughout the sampling program. The logbook should be used in support of, and/or in combination with, the sample collection record or electronic data collector. Documentation within the logbook should be thorough and sufficiently detailed to present a concise, descriptive history of the sample collection process.

7.4 Sample Labels

Sample labels shall be completed at the time each sample is collected and attached to each sample container. Sample labeling will be conducted per this SAP and the QAPP. Labels will include the information listed below.

- Client or project name/project number,
- Sample number or designation,
- Analysis type,

- Preservative,
- Sample collection date,
- Sample collection time, and
- Sampler's name.

The records generated in this procedure will become part of the permanent record supporting the associated field work. All documentation will be retained in the project files following project completion.

8.0 QUALITY ASSURANCE & QUALITY CONTROL

Field personnel should follow specific quality assurance guidelines as outlined in the QAPP and/or this SAP.

Quality assurance requirements typically suggest the collection of a sufficient quantity of quality control (QC) samples such as field duplicate, equipment and/or field blanks and matrix spike/matrix spike duplicate (MS/MSD) samples. These requirements are outlined in the QAPP.

9.0 REFERENCES

Enbridge, 2011a. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Sampling and Analysis Plan (SAP). August 30, 2011.

Enbridge, 2011b. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Quality Assurance Project Plan (QAPP). August 19, 2011.

Enbridge, 2010. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Health and Safety Plan (HASP). August 2010.

SOP EN-102 – Chain of Custody Procedures.

SOP EN-103 – Packaging and Shipment of Environmental Samples.

SOP EN-105 – Decontamination of Field Equipment.

SOP EN-403 – Water Level Measurement in a Monitoring Well

SOP EN 502 – Water Quality Instrumentation

United States Environmental Protection Agency, Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures (U.S. EPA April 1996.

United States Environmental Protection Agency, Region 1, Low Stress (low flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells, Revision No. 3 (U.S. EPA January 2010.

Approved

Enbridge Line 6B MP 608

Marshall, MI Pipeline Release

Sample Collection from Drinking Water Wells – SOP EN-405

Prepared for Michigan Department of Environmental Quality

Enbridge Energy, Limited Partnership

Submitted: November 11, 2010

Approved: August 30, 2011

Approved

ATTACHMENT

Approved

LIST OF ACRONYMS

CFR	Code of Federal Regulations
HASP	Health and Safety Plan
HCl	Hydrochloric Acid
Line 6B	The pipeline owned by Enbridge Energy, Limited Partnership that runs just south of Marshall, Michigan
MDEQ	Michigan Department of Environmental Quality
ml	milliliter
MS/MSD	Matrix Spike/Matrix Spike Duplicate
OSHA	Occupations Safety and Health Administration
QAPP	Quality Assurance Project Plan
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedure
VOA	Volatile Organic Analysis
VOC	Volatile Organic Compound

1.0 SCOPE & METHOD SUMMARY

This Standard Operation Procedure (SOP) describes the basic techniques/procedures and general considerations to be followed for the collection of valid and representative samples from drinking water supply wells, typically domestic wells at residential households.

Sampling of drinking water wells generally involves opening an existing spigot or tap on the water distribution system within a residence. Prior to sample collection, the water should be run for fifteen 15 minutes to flush stagnant water from the system. Samples shall not be collected from the hot water piping (i.e., after a hot-water heater or other heating system) or after a treatment system. In addition, samples are to be collected directly from the spigot, not from hoses or tubing.

It is expected that the procedures outlined in this SOP will be followed. Procedural modifications may be warranted depending on field conditions, equipment limitations, or limitations imposed by the procedure. Substantive modification to this SOP will be noted in task-specific work plans or on Field Modification Forms as appropriate and will be approved in advance by the Task Manager. Deviations from the SOP will be documented in the project records and in subsequent reports.

2.0 PERSONNEL QUALIFICATIONS

Collecting drinking water well samples is a relatively simple procedure requiring minimal training and a relatively small amount of equipment.

Field personnel must be health and safety certified as specified by the Occupational Safety and Health Administration (OSHA) (29 CFR 1910.120(e)(3)(i)) to work on sites where hazardous materials may be present.

It is the responsibility of the field sampling personnel to be familiar with the sampling procedures outlined within this SOP, and with specific sampling, quality assurance, and health and safety requirements outlined in this *Sampling and Analysis Plan (SAP)* (Enbridge, 2011a), the *Quality Assurance Project Plan (QAPP)* (Enbridge, 2011b), and the *Health and Safety Plan (HASP)* (Enbridge, 2010). Field personnel are responsible for the proper use, maintenance, and decontamination of all equipment used for sampling, as well as proper documentation in the field logbook, field forms, or electronic documentation (if appropriate).

3.0 HEALTH AND SAFETY

The health and safety considerations for the work associated with this SOP, including both potential physical and chemical hazards, is addressed in the site specific HASP. All work will be conducted in accordance with the HASP.

4.0 INTERFERENCES

Potential interferences could result when the groundwater pumped from the subsurface comes in contact with the distribution system and/or water treatment system. These potential interferences will be minimized by allowing water to run prior to sample collection, selection of a sampling location that minimizes contact with the distribution system, and ensuring that samples are collected prior to any treatment system. If a sample cannot be collected prior to a treatment system, then a note will be added to the field documentation explaining why the sample was collected after treatment.

5.0 EQUIPMENT & SUPPLIES

The following equipment list contains materials which may be needed to carry out the procedures contained in this SOP. Not all equipment listed below may be necessary for a specific activity. Additional equipment may be required, pending field conditions.

- Hose at least 15 feet long or tubing;
- Sample kit (*i.e.*, bottles, labels, preservatives, custody records and tape, cooler, ice);
- Empty sample bottles (no preservatives) for sample collection if spigot is awkwardly positioned;
- Sample Chain of Custody forms (as required by *SOP EN-102 - Chain of Custody Procedures*);
- Sample packaging and shipping supplies (as required by *SOP EN-103 - Packaging and Shipment of Environmental Samples*);
- Waterproof marker ;
- Distilled/deionizer water supply;
- Deionized water dispenser bottle;
- Buckets;
- Paper towels;
- Trash bags;
- Zipper-lock bags
- Camera,
- Equipment decontamination supplies (as required by *SOP EN-105 - Decontamination of Field Equipment*);
- Health and safety supplies (as required by the HASP);
- Field form or electronic data collector such as the Trimble Yuma® or equivalent (if applicable); and
- Field logbook/pen.

6.0 METHODS

6.1 Access and Well Information

Prior to sampling at each location, a formal well survey will be conducted. The well owner will be interviewed to obtain any available information about well location, depth, and construction, and information about the water distribution in the house so that an appropriate sample location can be selected. The results of the well survey will be documented in the field logbook, appropriate form, and/or electronic data collector.

It is the responsibility of the Task Manager to ensure that permission for sampling of drinking water wells has been received from the property owner or other responsible party. It is the responsibility of the field personnel to contact the property owner concerning the proposed date and time of the sampling, if noted that it was requested by the owner during the validation process. It is also the responsibility of the field personnel to contact the owner if the sampling schedule is changed.

6.2 Selection of Sample Point

Within the residence, a location along the existing water distribution system must be selected from which the sample will be collected. All taps or spigots are potential sampling locations. The sample location will be selected at the spigot within the house as close to the wellhead as possible. Ideally, the first tap or spigot will be located on the system as soon as the piping enters the house. If this is not possible, the following criteria will be considered:

- In no case will the sample be collected from the hot water piping (*i.e.*, after a hot-water heater or other heating system).
- Locations at spigots in the piping are preferred over taps at sinks, as many taps may include aeration, filters, or other features. An outdoor spigot or utility sink is less likely to have these features.
- As the water will be run for several (at least 15) minutes prior to sampling, a location near a sink or drain is more convenient (but not required).

If a sample location meeting these criteria cannot be identified, then no sample will be collected. The location of the selected sample point will be documented in the field logbook, appropriate form, and/or electronic data collector. If no sample is collected from a particular drinking water well, the reason must be documented.

6.3 Well Purging

Prior to sample collection, the water will be run for approximately fifteen (15) minutes to flush stagnant water out of the piping. The water may be run from the sampling point directly into a sink or drain, or piped to a sink or drain using hose or tubing. If there is no drain or sink convenient to the sample location, the water can be run from any tap in the house. The well owner's convenience should be consulted to determine the correct process. If using an outdoor spigot be sure to purge water away from homes in grassed areas or in designated areas requested by home owner to avoid any erosion damage to property.

The purging process, including duration, will be documented in the field logbook, sample collection form, and electronic data collector.

6.4 Sample Collection and Preservation

Water from the sampling point will be used to fill the appropriate bottle(s) supplied by the laboratory. Water will continue to be run from the sampling point continuously, without turning off the water between bottles. It may be convenient for this to take place over a sink, drain, or bucket. Remove hoses and tubing before sampling is conducted. Sample collection from the purging hose or tubing will not be allowed. Be sure to sample directly from sampling point (*i.e.* from tap or spigot).

If unable to put sampling jars directly under spigot, use clean, un-used and unpreserved jars to fill all other jars. Additional sample jars used in sampling but not submitted for analysis will be disposed of after each use.

Sample jars will be filled in accordance to laboratory requirements. If samples are collected for the analysis of Volatile Organic Compounds (VOCs), they will be preserved during sampling as required by the Michigan Department of Environmental Quality (MDEQ). . In order to preserve the VOC sample, fill containers half way, add 5 drops of hydrochloric acid (HCL) (5 drops per 40 ml container), and fill the continer with tap water the rest of the way.

6.5 Sample Handling

- Label all sampling containers prior to sampling to avoid adhesive malfunctions. Once sample jars are wet, the labels will likely not stick. Label the container with (at a minimum) the sample identifier and sampling date and time. Additional information such as preservation information and analytical tests will also be added to the sample label as appropriate. Sample labeling will be conducted per this SAP and the QAPP.
- Cap all samples immediately after sampling to avoid any environmental or biological contamination such as leaves, insects, or soil.
- All bottles filled for the analysis of VOCs including trip blanks, will be transported in the same bag and cooler. All samples collected at one location (excluding VOCs) will be transported in one ziplock bag with the sample identification written on the front in permanent marker.
- Place the sample containers into a cooler and maintain on ice.
- At end of work day, transport samples to the sample pick-up location,. All samples will be subjected to a quality control inspection and compared to the chain of custody before laboratory delivery.
- Package the samples for shipment to the laboratory per *SOP EN-103 - Packaging and Shipment of Environmental Samples*.

6.6 Equipment Decontamination

Typically, no equipment decontamination is needed after drinking water well sampling, because all materials are disposable or dedicated (*e.g.*, the household water distribution system). However, any necessary decontamination will be performed in accordance with *SOP EN-105 - Decontamination of Field Equipment*.

Approved

7.0 DATA & RECORDS MANAGEMENT

Specific information regarding sample collection should be documented in several areas: the sample chain of custody record, field logbook, electronic data collector, and sample labels. Additional information regarding each form of documentation is presented in the following paragraphs.

7.1 Sample Chain of Custody Record

This standard form requires input of specific information regarding each collected sample for laboratory analytical purposes, as specified in *SOP EN-102 - Chain of Custody Procedures* and *SOP EN-103 - Packaging and Shipment of Environmental Samples*). Please follow *SOP EN-405 Attachment 1* when producing a chain of custody for samples collected from drinking water wells. This electronic chain should be printed for the quality control inspection of samples as stated above and for sample delivery.

7.2 Field Logbook/Electronic Data Collector

This logbook and/or electronic data collector should be dedicated to the project and should be used by field personnel to maintain a general log of activities throughout the sampling program. This documentation should be used in support of, and in combination with, the sample collection record. Documentation within the logbook or electronic data collector should be thorough and sufficiently detailed to present a concise, descriptive history of the sample collection process. Information that should be documented for each sample includes: time arrived on site, property address, property identification (e.g. C#), sample identification and duplicate identification (if applicable), start purge, sample time, and notes (MS/MSD, property observations, encounters with property owners, etc).

7.3 Sample Labels

Sample labels shall be completed at the time each sample is collected and attached to each sample container per this SAP and the QAPP. Labels may include the information listed below.

- Client or project name/project number,
- Sample number,

- Sample designation and location,
- Analysis type,
- Preservative,
- Sample collection date,
- Sample collection time, and
- Sampler's name.

The records generated in this procedure will become part of the permanent record supporting the associated field work. All documentation will be retained in the project files following project completion.

8.0 QUALITY ASSURANCE & QUALITY CONTROL

Quality control /Quality Assurance requirements are dependent on task specific sampling objectives. The QAPP provides requirements for equipment decontamination (frequency and materials), sample preservation and holding times, sample container types, sample packaging and shipment, as well as requirements for the collection of various quality assurance samples such as trip blanks, field blanks, equipment blanks, and field duplicate samples.

Field personnel should follow specific quality control/Quality assurance guidelines as outlined in the QAPP and/or this SAP. See the QAPP for collection frequency and methods.

9.0 REFERENCES

Enbridge, 2011a. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Sampling and Analysis Plan (SAP). August 30, 2011.

Enbridge, 2011b. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Quality Assurance Project Plan (QAPP). August 19, 2011.

Enbridge, 2010. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Health and Safety Plan (HASP). August 2010.

SOP EN-102 - Chain of Custody Procedures

SOP EN-103 - Packaging and Shipment of Environmental Samples

SOP EN-105 - Decontamination of Field Equipment

SOP EN-405 – Sample Collection from Drinking Water Wells, Attachment 1

Attachment 1

How to Create a Chain of Custody (COC) Using the Potable COC Macro File

How to Create a Chain of Custody (COC) Using the Potable COC Macro File

1. On the desktop of the Yuma, open the folder labeled "Potable-COC's". These steps must take place on the Yuma only. The data that it needs for the COC is on the Yuma. Do not transfer this file to a computer until the file is **save-as'ed** (step 9).
2. Double click on the file "COC Macro file". Do not save or save-as till you have run the macro. While running, it will not recognize the file name if you change it before you run the macro.
3. Where it says "Security Warning" press the button that says "Options" and select "Enable this content."
4. Make sure you are on the "Home Page For Macros" tab located in the bottom left corner.
5. Press the button labeled "Open Arcpad .dbf File"
6. To locate the .dbf file you need to use for the COC, you must go to
    a) Local Disk (C:)
    b) Double click on "Projects" folder
    c) Double click on "ArcPad" folder
    d) Select file "sam_xfer.dbf"
    e) Press open
7. Let the macro run for about 2 to 3 seconds. A screen will pop up asking for "Enter Date to pull COC data:" This is the date that you collected the samples you would like to have displayed on the COC. The COC's should be produced the same day you collected the samples…no exceptions. Please type the date in (MM/DD/YYYY) then press "OK."
8. Let it run for about 2 to 3 seconds. Your COC should have been produced. Press the "COC" tab in the bottom left corner of the screen to see your COC.
9. At this time you may **save-as**. **DO NOT PRESS THE SAVE BUTTON!!!** This will save the new COC over our template. Go to the circle in the upper left corner (File), and select "Save-as". Save the file with the following standard:
    a) ENBRIDGE_POTABLE_the sampling parameter list (A or B)_date(MMDDYY)
    b) Example: ENBRIDGE_POTABLE_B_062211
    c) A = long list (Bi-weekly), B = short list (Monthly and Quarterly)
10. Double check all samples. Make sure all duplicates and MS/MSD's are called out correctly. For some reason the number of sample jars that get automatically populated are never correct. You will have to correct them by hand.
11. Under the column "Additional Notes" all the way to the right of the COC, please select from the drop down menu trip blank, dup, or ms/msd if they apply.
12. Additional information that needs to be entered:
    a) At the very bottom of the COC, please type in the sampler's names under "Sampler Name and Signature."
    b) At the very top, enter the page number (1 of_), the total # of samples (including trip blanks), and under task put "Potable List _" (A or B).
    c) Above each sample parameter, please use the drop down menu to select the preservative.
13. Trip blanks will not automatically populate in the COC. You must enter them by hand. The cells that were not used are not formatted. When you enter the information in the

empty rows, you will have to adjust them so that the information is displayed in the same manner.

- If using a mouse, highlight cells, right click then select format cells. Under "Alignment" tab, select "Merge cells." Do this for all cells you are going to use.
- If using a stylus, highlight cells, press down and hold until a circle appears. Select format cells. Under "Alignment" tab, select "Merge cells." Do this for all cells you are going to use.

14. Once COC is complete, print for sample QC (Bill Wagner-Superior Environmental). If Yuma is not connected wirelessly, please do one of the following:
    - Connect printer cable to Yuma then print that way.
    - Put COC file on a USB, and transfer to a computer connected to a printer.
15. If no corrections, send COC to laboratory with samples and upload excel file to Share Point (https://extranet.aecom.com/sites/enbridgemarshall/Field%20Data/Forms/Useful.aspx). Each field tech should have a share point username and password. Go to "Field Work" then "ALS Lab COCs" and press "add document."
    - If you open the internet browser on the Yuma, it should automatically connect to the share point if you are at the superior building on Grand St.
    - If not, then please transfer COC to a computer connected to the internet.
16. You're almost done!! When closing COC on Yuma, do not save changes to "sam_xfer.dbf" file.

Approved

Enbridge Line 6B MP 608

Marshall, MI Pipeline Release

Groundwater Sampling via Temporary Wells– SOP EN-406

Prepared for Michigan Department of Environmental Quality

Enbridge Energy, Limited Partnership

Approved: August 30, 2011

Approved

Approved

LIST OF ACRONYMS

C	Celsius
CFR	Code of Federal Regulations
DO	dissolved oxygen
GFI	ground fault interrupt
HASP	Health and Safety Plan
L/min	liters per minute
MS/MSD	matrix spike/matrix spike duplicate
NTU	Nephelometric Turbidity Unit
ORP	Oxidation Reduction Potential
OSHA	Occupational Safety and Health Administration
PVC	poly vinyl chloride
QAPP	Quality Assurance Project Plan
QC	Quality Control
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedure
TOC	top of well casing
U.S. EPA	United States Environmental Protection Agency

1.0 SCOPE & METHOD SUMMARY

This Standard Operation Procedure (SOP) describes the basic techniques and general considerations to be followed for the collection of groundwater samples from temporary monitoring wells. The procedures presented in this SOP are taken from the United States Environmental Protection Agency (U.S. EPA) Science and Ecosystem Division's document *Groundwater Sampling* (U.S. EPA, 2007).

This SOP describes the method for collecting valid and representative samples of groundwater from temporary monitoring wells. This SOP is written such that consideration of different sampling equipment may be used in different instances for collecting representative groundwater samples. Groundwater sample collection generally involves purging the water that is non-representative of the formation water from a well prior to sample collection. Water quality indicator parameters are monitored until all parameters have stabilized for three successive readings. After the indicator parameters have stabilized, groundwater samples are then collected into the appropriate bottle or containers.

It is expected that the procedures outlined in this SOP will be followed. Procedural modifications may be warranted depending on field conditions, equipment limitations, or limitations imposed by the procedure. Substantive modification to this SOP will be noted in task-specific work plans or on Field Modification Forms as appropriate and will be approved in advance by the Task Manager. Deviations from the SOP will be documented in the project records and in subsequent reports.

2.0 PERSONNEL QUALIFICATIONS

Groundwater sample collection is a relatively involved procedure requiring formal training and a variety of equipment. It is recommended that initial sampling of groundwater wells be supervised by more experienced personnel.

Field personnel must be health and safety certified as specified by the Occupational Safety and Health Administration (OSHA) (29 CFR 1910.120(e)(3)(i)) to work on sites where hazardous materials may be present.

It is the responsibility of the field sampling personnel to be familiar with the sampling procedures outlined within this SOP, and with specific sampling, quality assurance, and health and safety requirements outlined in this *Sampling and Analysis Plan (SAP)* (Enbridge, 2011a), the *Quality Assurance Project Plan (QAPP)* (Enbridge, 2011b), and the *Health and Safety Plan (HASP)* (Enbridge, 2010). Field personnel are responsible for the proper use, maintenance, and decontamination of all equipment used for obtaining water level measurements, as well as proper documentation in the field logbook, field forms, or electronic documentation (as appropriate).

3.0 HEALTH AND SAFETY

Groundwater sampling may involve physical and/or chemical hazards associated with exposure to groundwater or materials in contact with groundwater. When groundwater sampling is performed, adequate health and safety measures must be taken to protect field personnel. These measures are addressed in the project HASP. All work will be conducted in accordance with the HASP.

4.0 INTERFERENCES

Potential interferences could result from cross-contamination between samples and sample locations. Minimization of cross-contamination will occur through the use of disposable or decontaminated sampling equipment at each location. Decontamination of sampling equipment is discussed in *SOP EN-105 - Decontamination of Field Equipment*.

Potential interferences could result from the power source (e.g. generator). Minimization of contamination will occur through locating the power source a sufficient distance away from the well and sampling equipment and handling the power source with dedicated or disposable gloves.

Approved

5.0 EQUIPMENT & SUPPLIES

The following equipment list contains materials which may be needed in carrying out the procedures contained in this SOP. Not all equipment listed below may be necessary for a specific activity. Additional equipment may be required, pending field conditions.

5.1 Well Construction Materials

Well construction materials are usually provided by the drilling subcontractor. The wells will be constructed from commercially available, flush-threaded, poly vinyl chloride (PVC) 1-foot long, 10 slot (0.010 inch) well screen and PVC riser pipe. Alternatively, tube wells may also be used. If field conditions require, sand pack and bentonite chips may also be used.

5.2 Other Required Materials

- Peristaltic pump;
- Field Instruments;
  - Individual or multi-parameter meter(s) to measure temperature, pH, specific conductance, dissolved oxygen (DO), oxidation reduction potential (ORP), and turbidity,
- Water level meter or oil-water interface probe;
- Tubing (Silicone and polyethylene (or as required));
- Sample Collection Records or Electronic Data Collector such as Trimble Yuma® or equivalent;
- Disposable nitrile gloves;
- Sample kit (i.e., bottles, labels, preservatives, cooler, ice);
- Filtration equipment (if necessary);
- Sample Chain of Custody forms (as required by *SOP EN-102 – Chain of Custody Procedures*);
- Sample packaging and shipping supplies (as required by *SOP EN-103 – Packaging and Shipment of Environmental Samples*);
- Waterproof marker or paint;
- Distilled or deionized water and dispenser bottles;
- Flow measurement cup or bucket;

- Buckets with lids;
- Power source (generator or 12-volt marine battery) and extension cords with ground fault interrupt (GFI) protection;
- Paper towels;
- Plastic sheeting;
- Trash bags;
- Ziploc-style bags;
- Equipment decontamination supplies (as required by *SOP EN-105 – Decontamination of Field Equipment*);
- Health and safety supplies (as required by the HASP); and
- Field project logbook.

6.0 METHODS

6.1 Installation of Temporary Well

6.1.1 Borehole Preparation

Standard direct push methods should be used by the drilling subcontractor under the supervision of field personnel to achieve the desired target depths. A hand auger (or equivalent manual technique) may be used at shallow well locations not accessible by a drilling rig.

The typical diameter of the borehole will be a minimum of 2 inches to allow sufficient annular space for natural collapse of the subsurface materials around the screen.

If the borehole is installed using hand auger techniques, a bucket auger will be used to install the boring to the proposed depth. If the soil conditions do not allow the boring to remain open, a 4 – to 6-inch diameter casing may be driven to depth to keep soil from collapsing into the boring. The temporary well would be installed through the 4 – to 6-inch casing which would then be removed leaving the temporary well in place.

If field conditions require, sand pack may be placed around the screen and bentonite chips will extend from the top of the filter pack to ground surface to ensure the sample is being collected from the screened interval.

6.2 Water Level Measurement

Identify a consistent measuring point for all temporary wells. Generally, the measuring point is referenced from the top of the well casing (TOC) on the north side of the casing.

Water level measurements should be collected in accordance with *SOP EN-403 – Water Level Measurements in a Monitoring Well* with the following modification. The temporary well TOC will be several inches to several feet above the ground surface. Upon the water level or interface probe signaling top of water in the temporary well grasp the level/probe tape between thumb and forefinger at the TOC measuring point. While maintaining a firm grip, drag the grasped section of level/probe tape straight down to the ground surface. This maneuver removes the above ground portion of the temporary well from the depth to groundwater measurement. With the grasped area of level/probe tape at ground surface, read the measurement at the TOC. This measurement will be the depth to groundwater from ground surface.

Collect a depth to bottom of the temporary well in the same manner as the depth to groundwater was collected. The water level measurements should be entered on appropriate field documentation.

6.3 Instrument Calibration

Field instruments will be calibrated according to the requirements of the QAPP and manufacturer's specifications for each piece of equipment (e.g., *SOP EN-502 - Water Quality Instrumentation*). Calibration records shall be recorded in the field logbook, appropriate field form, or electronic data collector.

6.4 Well Purging Methods and Procedures

6.4.1 Objectives

Prior to sample collection, purging must be performed for the temporary monitoring wells to remove fine grained materials from within the casing and immediate surrounding subsurface sediments and to remove a volume of groundwater in the subsurface directly affected by the installation process. Purging in this manner is to ensure that a representative groundwater sample is obtained.

All groundwater samples will be collected using low flow (low-stress) purging and sampling procedures. The low-flow method emphasizes the need to minimize water level drawdown and low groundwater pumping rates to collect samples with minimal alterations to groundwater chemistry.

For this project, a peristaltic pump with disposable tubing will be used. Purge water will be pumped directly into a bucket or containment vessel. The flow rate will be recorded on field documentation. A final purging rate will be selected that does not exceed 0.3 liters per minute (L/min).

Purge water will be pumped through a flow-through cell and the following parameters will be measured: pH, specific conductivity, temperature, DO, ORP, and turbidity. These parameters will be measured with a water quality meter, calibrated according to the manufacturer's specifications (see *SOP EN-502 - Water Quality Instrumentation*). Turbidity may also be measured separately with a nephelometer, also calibrated to the manufacturer's specifications. A round of parameter measurements will be recorded approximately 10 minutes after the flow-through cell is full, and then every 3 to 5 minutes thereafter, until parameter values have stabilized.

Purging is considered complete and sampling may begin when all parameter values have stabilized and turbidity is below 10 Nephelometric Turbidity Units (NTU). Stabilization is considered to be achieved when three consecutive readings, taken at 3- to 5-minute intervals, are within the following limits:

- Turbidity : less than 10 NTU or ± 10%
- DO : ± 10%
- Specific Conductance : ± 3%
- Temperature : ± 3% or less than 0.5 degrees C
- pH : ± 0.1 standard units
- ORP : ± 10 millivolts

Every effort will be made to lower the turbidity to less than 10 NTU before sampling. If the turbidity cannot be reduced to below 10 NTU, the pumping rate will be reduced for 10 minutes. If turbidity still cannot be reduced below 10 NTU, samples may be collected if all other parameters are stable and the turbidity is stable (i.e. not improving). The condition will be noted on the field documentation. During hot and cold weather sampling, short tubing lengths should be utilized to avoid temperature changes and freezing of the tubing – if the sample temperature does not stabilize as the water flows through tubing exposed to ambient temperatures, this should be noted in the field notes.

If after 30 minutes of purging, stabilization of parameters is not achieved, a sample will be collected and recorded in the field notes.

All purge water will be containerized and disposed per the project plan.

If a well purges dry, a groundwater sample will be collected when sufficient water has recharged the well. The condition will be noted on the field documentation.

6.5 Peristaltic Pumps

6.5.1 General

Well purging using pumps located at the ground surface can be performed with a peristaltic pump if the water level in the well is within approximately 20 feet of the top of the well.

Peristaltic pumps provide a low rate of flow typically in the range of 0.075-0.750 L/min. Peristaltic pumps are suitable for purging situations where disturbance of the water column must be kept minimal for particularly sensitive analyses.

6.5.2 Peristaltic Pump Procedure

Attach a new sample tube set-up to the peristaltic pump. Silicone tubing must be used through the pump head and must meet the pump head specifications. A second type of tubing (e.g., polyethylene) may be attached to the silicone tubing for use as the suction and discharge lines.

Measure the length of the suction line. Start the pump and slowly lower the suction line down the monitoring well until the end is located at the midpoint of the saturated screen. Direct the discharge into a graduated bucket. Adjust the pumping rate with the speed control knob so that a smooth flowing discharge is attained.

Measure the pumping rate by recording the time required to fill a flow measurement cup or bucket. The pumping shall be monitored to assure continuous discharge. If drawdown causes the discharge to stop, the suction line will be lowered very slowly further down into the well until pumping restarts.

6.6 Sample Collection Methods and Procedures

6.6.1 Objectives

Groundwater samples can be collected using similar methods employed for purging. In most cases during sampling, groundwater will be transferred to the appropriate containers directly from the discharge source. It is important that the tubing from the pump to the flow-through cell be disconnected prior to sample collection. During transfer, discharge tubing and other equipment shall not contact the inside of the sample containers.

Groundwater samples that may require filtration (as specified in the work plan), will be filtered in the field at the wellhead using a 0.45-micron, in-line filter.

Sample bottles shall be filled directly from the pump's discharge line (after tubing has been disconnected from the flow-through cell) and care shall be taken to keep the discharge tube from contacting the sample container.

6.7 Sample Handling and Preservation

- Cap and label the container with (at a minimum) the sample identifier, sampling date and time. Additional information such as preservation information and analytical tests may also be added to the sample label as appropriate.
- Place the sample containers into a cooler and maintain on ice.
- Complete sample chain of custody and other documentation per *SOP EN-102 – Chain of Custody Procedures*.
- Package the samples for shipment to the laboratory per *SOP EN-103 – Packaging and Shipment of Environmental Samples*.

6.8 Equipment Decontamination

All equipment that comes into contact with groundwater will be decontaminated in accordance with *SOP EN-105 – Decontamination of Equipment* protocol before moving to the next location. Dedicated or disposable equipment will not be decontaminated.

Approved

7.0 DATA & RECORDS MANAGEMENT

Specific information regarding sample collection should be documented in several areas: the sample chain of custody record; sample collection record, field logbook, or electronic data collector; and sample labels or tags. Additional information regarding each form of documentation is presented in the following paragraphs.

7.1 Sample Chain of Custody Record

This standard form requires input of specific information regarding each collected sample for laboratory analytical purposes, as specified in SOP EN-102 and EN-103.

7.2 Sample Collection Record or Electronic Data Collector

The sample collection record requires input of specific information regarding the collection of each individual sample including sample identification, water quality parameters, collection method, and containers/preservation requirements. An electronic data collector such as a Trimble Yuma® may be used in place of or in addition to the sample collection record.

7.3 Field Logbook

The logbook should be dedicated to the project and should be used by field personnel to maintain a general log of activities throughout the sampling program. The logbook should be used in support of, and/or in combination with, the sample collection record or electronic data collector. Documentation within the logbook should be thorough and sufficiently detailed to present a concise, descriptive history of the sample collection process.

7.4 Sample Labels

Sample labels shall be completed at the time each sample is collected and attached to each sample container. Sample labeling will be conducted per this SAP and the QAPP. Labels will include the information listed below.

- Client or project name/project number,
- Sample number or designation,
- Analysis type,

- Preservative ,
- Sample collection date,
- Sample collection time, and
- Sampler's name.

The records generated in this procedure will become part of the permanent record supporting the associated field work. All documentation will be retained in the project files following project completion.

8.0 QUALITY ASSURANCE & QUALITY CONTROL

Field personnel should follow specific quality assurance guidelines as outlined in the QAPP and/or this SAP.

Quality assurance requirements typically suggest the collection of a sufficient quantity of quality control (QC) samples such as field duplicate, equipment and/or field blanks and matrix spike/matrix spike duplicate (MS/MSD) samples. These requirements are outlined in the QAPP.

9.0 REFERENCES

Enbridge, 2011a. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Sampling and Analysis Plan (SAP). August 30, 2011.

Enbridge, 2011b. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Quality Assurance Project Plan (QAPP). August 19, 2011.

Enbridge, 2010. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Health and Safety Plan (HASP). August 2010.

SOP EN-102 – Chain of Custody Procedures.

SOP EN-103 – Packaging and Shipment of Environmental Samples.

SOP EN-105 – Decontamination of Field Equipment.

SOP EN-403 – Water Level Measurement in a Monitoring Well

SOP EN 502 – Water Quality Instrumentation

United States Environmental Protection Agency*, Science and Ecosystem Division Groundwater Sampling* (U.S. EPA November 1, 2007).

Approved

Enbridge Line 6B MP 608
Marshall, MI Pipeline Release

Headspace Analysis of VOCs in Unsaturated Soil Samples – SOP EN-501

Prepared for Michigan Department of Environmental Quality

Enbridge Energy, Limited Partnership

Submitted: November 11, 2010

Approved: August 30, 2011

Approved

Approved

LIST OF ACRONYMS

°C	degrees Celsius
°F	degrees Fahrenheit
eV	electron volts
IDW	investigation derived waste
HASP	Health and Safety Plan
NIOSH	National Institute for Occupational Safety and Health
oz	ounce
PPE	personal protective equipment
ppm	parts per million
PID	photoionization detector
QA/QC	Quality Assurance/Quality Control
SOP	Standard Operating Procedure
UV	ultraviolet
VOCs	Volatile Organic Compounds

1.0 SCOPE & METHOD SUMMARY

This Standard Operating Procedure (SOP) provides guidance for the headspace analysis to screen for volatile organic compounds (VOCs) in unsaturated soil samples using a Photoionization Detector (PID) (OVM®, MiniRAE®, or equivalent).

It is expected that the procedures outlined in this SOP will be followed. Procedural modifications may be warranted depending on field conditions, equipment limitations, or limitations imposed by the procedure. Substantive modification to this SOP will be noted in task-specific work plans or on Field Modification Forms and will be approved in advance by the Task Manager. Deviations from the SOP will be documented in the project records and in subsequent reports.

2.0 PERSONNEL QUALIFICATIONS

The Project Manager is responsible for ensuring that project-specific requirements are communicated to the project team and for providing the materials, resources, and guidance necessary to perform the measurements in accordance with this SOP and any associated work plan(s).

The field operator is responsible for verifying that the PID is in proper operating condition prior to use and for implementing the calibration and measurement procedures in accordance with this SOP and any associated work plan(s).

It is the responsibility of the field staff to conduct headspace analysis in a manner which is consistent with this SOP. Field staff will also record all pertinent data into a digital capture device, onto a boring log or into a field logbook.

3.0 HEALTH AND SAFETY

The health and safety considerations for the work associated with this SOP, including both potential physical and chemical hazards, are addressed in the site specific *Health and Safety Plan (HASP)* (Enbridge, 2010). All work will be conducted in accordance with the HASP.

4.0 INTERFERENCES

Regardless of which gas is used for calibration, the instrument will respond to all analytes present in the sample that can be detected by the type of lamp used in the PID.

Moisture will generate a positive interference in the concentration measured for a PID and is characterized by a slow increase in the reading as the measurement is made. Care must be taken to minimize uptake of moisture to the extent possible. Refer to the manufacturers' instructions for care, cleaning, and maintenance.

Uptake of soil into the PID must be avoided as it will compromise instrument performance by blocking the probe, causing a positive interference, or dirtying the PID lamp. Refer to the manufacturers' instructions for care, cleaning, and maintenance.

The user should listen to the pitch of the sampling pump. Any changes in pitch may indicate a blockage and corrective action should be initiated.

Make sure readings are not collected near a vehicle exhaust or downwind of the drill rig exhaust.

Potential interferences could result from cross-contamination between sample locations. Change gloves between samples to avoid cross contamination. Also, minimize cross-contamination through the use of clean sampling equipment at each location. Decontamination of sampling equipment is acceptable, therefore non-disposable sampling equipment will be decontaminated according to *SOP EN-105 – Decontamination of Field Equipment.*

Approved

5.0 EQUIPMENT & SUPPLIES

The following equipment list contains materials which may be needed in carrying out the procedures contained in this SOP. Not all equipment listed below may be necessary for a specific activity. Additional equipment may be required, pending field conditions.

- PID (with correct sized lamp as determined by the Task Manager and communicated in the work plan),
- Ziploc® Bags or equivalent (either quart or gallon size) or glass jars (8 oz or 16 oz) with aluminum foil,
- Field Notebook or Soil Boring/Monitoring Well Log Sheet or digital capture device (such as Trimble® Yuma®),
- Pen with indelible ink (blue or black ink),
- Permanent marker,
- Personal protective equipment (PPE) and health and safety equipment as specified in the HASP.

6.0 METHODS

6.1 Preparation

Review available project information to determine the types of organic vapors that will likely be encountered to select the right instrument. The correct ultraviolet (UV) light bulb must be selected according to the types of organic vapors that will likely be encountered. The energy of the UV light must equal or exceed the ionization potential of the organic molecules that the PID will measure. *The National Institute for Occupational Safety and Health (NIOSH) Pocket Guide to Chemical Hazards* is one source for determining ionization potentials for different chemicals. Bulbs available for PIDs include 9.4 electron volts (eV), 10.6 (or 10.2) eV, and 11.7 eV bulbs. The 10.6 eV bulb is most commonly used as it detects a fairly large range of organic molecules and does not burn out as easily as the 11.7 eV bulb. The 9.4 eV bulb is the most rugged, but detects only a limited range of compounds. Under very humid or very cold ambient conditions, the window covering the UV light may fog up, causing inaccurate readings.

After selecting the correct instrument, calibrate the PID according to *SOP EN-503 Calibration and Operation of a Photoionization Detector*. Record background/ambient levels of organic vapors measured on the PID after calibration and make sure to subtract the background concentration (if any) from your readings. Check the PID readings against the calibration standard every 20 readings or at any time when readings are suspected to be inaccurate, and recalibrate, if necessary. Be aware that, after measuring highly contaminated soil samples, the PID may give artificially high readings for a time due to saturation.

6.2 Equipment Decontamination

If new Ziploc® bags or new glass jars will be used with each new sample, equipment decontamination will not be required. If previously used glass jars are used, all soil should be removed from the used jars and the jars should be rinsed out with tap water. The jars should be allowed to dry. Once dry, the jars should be checked with a PID. The previously used jars should only be re-used if the PID reading is 0.0 parts per million (ppm). Removed soil and rinse water should be managed according to *SOP EN-106 Investigative Derived Waste Management*.

6.3 Sampling Procedure - Ziploc® Bags

Place a quantity of soil in a top-sealing plastic bag and seal the bag immediately. The volume of soil to be used should be determined by the Task Manager or Field Task Manager. Ideally, the bag should be at least 1/10th-filled with soil and no more than half-filled with soil. Once the bag is sealed, shake the bag to distribute the soil evenly. If the soil is hard or clumpy, use your fingers to gently work the soil (through the bag) to break up the clumps. Do not use a sampling instrument or a rock hammer since this may create small holes in the plastic bag and allow organic vapors to escape. Alternatively, the sample may be broken up before it is placed in the bag. Use a permanent marker to record the following information on the outside of the bag:

- Site identification information (i.e., borehole number),
- Depth interval, and
- Time the sample was collected.

Headspace should be allowed to develop before organic vapors are measured with a PID. Allow the headspace to develop inside the bag for a minimum of five minutes. Equilibration time should be the same for all samples to allow an accurate comparison of organic vapor levels between samples. However, adjustments to equilibration times may be necessary when there are large variations in ambient temperature from day to day. When ambient temperatures are below 32 degrees Fahrenheit (°F) (0 degrees Celsius [°C]), headspace development should be within a heated building or vehicle. When heating samples, be sure there is adequate ventilation to prevent the build-up or organic vapors above action levels.

Following headspace development, open a small opening in the seal of the plastic bag. Insert the probe of the PID and seal the bag back up around the probe as tightly as possible, minimizing the air loss from the bag. Alternatively, the probe can be inserted through the bag to avoid loss of volatiles. If this alternative method is used, make sure the PID probe does not get clogged with plastic when puncturing the bag. Since PIDs are sensitive to moisture, avoid touching the probe to the soil or any condensation that has accumulated inside of the bag. Since the PID consumes organic vapors, gently agitate the soil sample during the reading to release fresh organic vapors from the sample. Analyze the sample with the PID for at least one minute, making note of the average and peak readings. Record the PID results (in ppm) in the field notebook, soil boring/monitoring well log, or digital capture device. Dispose of the soil with the rest of the investigation derived waste (IDW) in accordance with *SOP EN-106 Investigative Derived Waste Management.*

6.4 Sampling Procedure - Jars with Aluminum Foil

Half-fill a clean glass jar with the soil sample to be screened. Quickly cover the jar's opening with one or two sheets of clean aluminum foil and apply the screw cap to tightly seal the jar. Use a permanent marker to record the following information on the top of the foil seal or jar cap:

- Site identification information (i.e., borehole number),
- Depth interval, and
- Time the sample was collected.

Allow headspace development for at least five minutes. Equilibration time should be the same for all samples to allow an accurate comparison of organic vapor levels between samples. However, adjustments to equilibration times may be necessary when there are large variations in ambient temperature from day to day. Vigorously shake the jar for 15 seconds, both at the beginning and at the end of the headspace development period. When ambient temperatures are below 32°F (0 °C), headspace development should be within a heated area. When heating samples, be sure there is adequate ventilation to prevent the build-up of organic vapors above action levels.

Subsequent to headspace development, remove the jar lid and expose the foil seal. Quickly puncture the foil seal with the PID probe, to a point about one-half of the headspace depth. Exercise care to avoid uptake of water droplets or soil particulates. Analyze the sample with the PID for at least one minute, making note of the average and peak readings. Record the PID results (in ppm) in the field notebook, soil boring/monitoring well log, or digital capture device. Dispose of the soil with the rest of the IDW in accordance with *SOP EN-106 Investigative Derived Waste Management.*

7.0 DATA & RECORDS MANAGEMENT

All data generated (results and duplicate comparisons) will be recorded in the field notebook, electronic data collector, and/or on the field form. Any deviation from the outlined procedure will also be noted. Data to be recorded includes:

- Field conditions,
- Field personnel performing task,
- When the PID was calibrated (date/time) and calibration standard used,
- Background/ambient concentrations measured after PID calibration,
- Location of sample (i.e., bore-hole number),
- Depth interval of sample measured,
- Lithology of material measured, and
- PID readings (average and peak) and units of measure.

Note that if PID measurements are recorded on a boring log, it is not necessary to duplicate information in the column where the PID readings are recorded (e.g., borehole number, depth interval, lithology type).

All documentation will be stored in the project files and retained following completion of the project.

8.0 QUALITY ASSURANCE AND QUALITY CONTROL

Quality Assurance/Quality Control (QA/QC) will include the collection of duplicate samples. In general, one duplicate will be collected per 10 samples. Average readings for organic vapor concentrations measured in the primary and duplicate samples should be within plus or minus 20 percent. The actual frequency of headspace duplicate collection will be determined by the Task Manager. Periodically check ambient organic vapor levels. If ambient levels have changed more than 20 percent, check the PID and recalibrate if necessary.

9.0 REFERENCES

Enbridge, 2010. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Health and Safety Plan (HASP). August 2010*.*

SOP EN-105 – Decontamination of Field Equipment

SOP EN-106 – Investigative Derived Waste Management

SOP EN-503 – Calibration and Operation of a Photoionization Detector

Approved

Enbridge Line 6B MP 608

Marshall, MI Pipeline Release

Water Quality Instrumentation– SOP EN-502

Prepared for Michigan Department of Environmental Quality

Enbridge Energy, Limited Partnership

Approved: August 30, 2011

TABLES

Approved

LIST OF ACRONYMS

°C	degrees Celsius
DI	Deionize
DIUF	deionized ultra-filtered water
DO	dissolved oxygen
HASP	Health and Safety Plan
MDS	Multi parameter Display System
mg/L	Milligrams per liter (parts per million)
mV	millivolts
NIST	National Institute of Standards & Technology
ORP	Oxidation Reduction Potential
PPE	Personal Protective Equipment
RF	Outside Electronic Noise
SOP	Standard Operating Procedure
µS/cm	microsiemen per centimeters
U.S. EPA	United States Environmental Protection Agency
YSI	YSI Incorporated

1.0 SCOPE & METHOD SUMMARY

The purpose of this standard operating procedure (SOP) is provide a framework for calibrating instruments used to measure water quality parameters for ground water and surface water. Water quality parameters include temperature, pH, dissolved oxygen (DO), conductivity/specific conductance, and oxidation reduction potential (ORP). .

This SOP is written specifically for the YSI Model 6-Series Sondes (which include the 600R, 600XL, 600XLM, 6820, 6920 and 6600 models), and the YSI 650 MDS (Multi parameter Display System) display/logger. However, the general calibration processes discussed herein are applicable to the YSI Professional Plus and other manufactures sondes and displays/loggers (e.g., Horiba U-22, InSitu Troll 9500). Consult the manufacturer's instruction manuals for specific procedures.

It is expected that the procedures outlined in this SOP will be followed. Procedural modifications may be warranted depending on field conditions, equipment limitations, or limitations imposed by the procedure. Substantive modification to this SOP will be noted in task-specific work plans or on Field Modification Forms as appropriate and will be approved in advance by the Task Manager. Deviations from the SOP will be documented in the project records and in subsequent reports.

2.0 PERSONNEL QUALIFICATIONS

The Project Manager is responsible for ensuring that project-specific requirements are communicated to the project team and for providing the materials, resources, and guidance necessary to perform the measurements in accordance with this SOP and the project plans.

The field operator is responsible for verifying that the YSI is in proper operating condition prior to use and for implementing the calibration and measurement procedures in accordance with this SOP and the project plan.

3.0 HEALTH AND SAFETY

The health and safety considerations for the work associated with this SOP, including both potential physical and chemical hazards, are addressed in the site specific *Health and Safety Plan (HASP) (Enbridge, 2010).* All work will be conducted in accordance with the HASP.

Site investigation activities may involve physical and/or chemical hazards associated with exposure to water, sediment, or materials in contact with either water or sediment. When sediment sampling is performed, adequate health and safety measures must be taken to protect field personnel. These measures are addressed in the project HASP.

4.0 INTERFERENCES

Each of the parameters measured with this procedure is subject to various interferences including cross-contamination, turbidity, aeration, and temperature fluctuations. Care must be taken to ensure that the instrument remains in a stable, controlled environment throughout the calibration and monitoring process and that the conditions under which the samples are analyzed are the same as those under which calibration is conducted.

5.0 EQUIPMENT & SUPPLIES

The following equipment list contains materials which may be needed in carrying out the procedures contained in this SOP. Not all equipment listed below may be necessary for a specific activity. Additional equipment may be required, pending field conditions.

- Thermometer (with National Institute of Standards and Technology [NIST] trace),
- pH Buffers of 4, 7, and 10 standard units,
- Conductivity standards (concentration dependent upon expected field conditions),
- Eureka ORP calibration standard (or similar)
- Zero Dissolved Oxygen Solution,
- Standard Deionized) Water provided by the laboratory,
- YSI Sonde with attached Turbidity, pH, Conductivity, DO, and ORP probes with clear flow-through cell or probe guard,
- YSI 650 MDS Multiparameter Display System (display logger),
- Sonde communications cable,
- Ring stand or similar capable of holding the sonde and flow-through cell upright during low-flow groundwater sampling,
-
- Gallon-size plastic freezer bags (e.g. Ziploc) to protect the MDS and the top of the Sonde from rain,
- Field data sheets, logbook, and/or electronic data capture device,
- Pen with indelible ink, and
- Personal protective equipment (PPE) and health and safety equipment as specified in the HASP.

6.0 METHODS

All instrument probes must be calibrated before they are used to measure environmental samples, and the calibration should be checked daily, if possible, and whenever any anomalous readings are obtained.

6.1 Set-up

Before performing any calibration procedure the sonde and display/logger must warm-up for at least 15 minutes.

During the warm-up period, set the sonde up on a ring stand.

Prior to calibration, all instrument probes on the sonde must be cleaned according to the manufacturer's instructions. Failure to perform this step can lead to erratic measurements. The probes must also be cleaned by rinsing with deionized (DI) water before and after immersing the probe in a calibration solution.

For each of the calibration solutions, provide enough volume so that the probe and the temperature sensor are sufficiently covered. Additional detail on volume is provided under each section and in the manufacturer's instructions.

Check the battery level in the display/logger to see if recharging or new batteries are necessary.

Set up instrument display so that the following items are displayed:

- DO %,
- ORP (mV),
- DO (milligrams per liter (mg/L)),
- Specific Conductivity (milli per centimeters (mS/cm)),
- Turbidity ,
- Temperature (°C), and
- pH (standard units).

6.2 Temperature

For instrument probes that rely on the temperature sensor (pH, dissolved oxygen/specific conductance, and ORP), the sonde temperature sensor needs to be checked for accuracy against a thermometer that is traceable to the NIST. This accuracy check should be performed at least once a year, and the date and results of the check kept with the instrument. Temperature checks will be performed by the rental company for rented units, and by the AECOM Equipment Manager for AECOM-owned units. Prior to mobilizing, obtain the date and results of the check from the equipment room manager or check the outside of the case for rental units. If the check has not been performed within the past year, do not use the instrument. Document the date, results, and company that performed the check on the calibration log sheet or in the field logbook. Below is the verification procedure:

- Allow a container filled with water and the sonde to equilibrate to room temperature, and
- Place a thermometer that is traceable to the NIST into the water and wait for both temperature readings to stabilize.

Compare the two measurements. The instrument's temperature sensor must agree with the reference thermometer within the accuracy of the sensor (+/- 0.15 degrees Celsius [°C]). If the measurements do not agree, the instrument may not be working correctly and the manufacturer should be contacted.

6.3 Dissolved Oxygen

The DO content in water is measured using a membrane electrode. The DO probe's membrane and electrolyte solution should be inspected for any damage or air bubbles prior to calibration. If air bubbles or damage are present, replace the membrane according to manufacturer's suggestions. After changing the membrane, it is preferable to wait 12 hours before use to allow the membrane to equilibrate if time allows. If this is not possible, note this in the calibration log. The YSI 6-Series DO probe must be calibrated using the calibration cup provided with the sonde. Calibration of the DO probe requires inputting the current barometric pressure. The YSI 650 display/logger has a barometer within the unit and automatically provides this during the calibration procedure. The barometric pressure for all units onsite should be checked for agreement between units, or checking using the onsite barometer. Other display/loggers do not supply the barometric pressure, and this must be obtained from other sources. Do not use barometric pressure obtained from meteorology reports as these are usually corrected to sea level.

Calibration is performed using 100% saturated air, and checked immediately after with a solution of zero dissolved oxygen. The calibration check at the end of the day also uses 100% saturated air.

6.3.1 DO Calibration

- Place a small amount of water (<1/8 inch) in the bottom of the calibration cup. Engage only one thread of the calibration cap onto the sonde so that the DO probe is readily vented to the atmosphere. Take care to avoid touching the oxygen membrane with the calibration cups and flow-cell. The DO probe and thermistor must not be in contact with the water. Keep the instrument in run mode and wait approximately 15 minutes for the air in the calibration cup to become water-saturated (100% humidity at atmospheric pressure) and the temperature to equilibrate. Set up the remaining instruments and solutions in the meantime.
- When the temperature has stabilized, go to Calibrate mode - Calibrate DO%
- Record the temperature on the calibration log. Check the barometric pressure reading on the YSI versus the barometer and other YSIs present. Record the barometric pressure on the calibration log. (Note: barometric pressures presented in meteorological reports are generally corrected to sea level. These are not useful for calibrating the sonde, which requires uncorrected barometric pressure).
- When the DO% and temperature readings have stabilized for at least one minute, press "enter". Record the number that appears on the screen. Record also the DO mg/L value.
- Check the oxygen solubility at that pressure and temperature on the attached Table 1 and record under "Std temperature/pressuree correction." The instrument DO reading should be comparable with the value on the table (within +0.2 mg/L). If not, recalibrate, or replace DO membrane.
- Make up the zero DO solution by filling the calibration cap with DI water, adding approximately 1 gram of sodium sulfite to supersaturate the solution. Add a few crystals of the cobalt chloride (purple salt) and stir. There should be solids on the bottom of the cap. Screw the cap tightly onto the YSI. Water should leak out to indicate that there is no air around the probes.

- Immediately after calibration, if the DO is at or below 0.50 mg/L, record the value on the calibration log. If the number stabilizes at a value > 0.50 mg/L, change the DO membrane. At the end of the day, if the DO is at or above 1.0 mg/L, note the failed criteria and the readings that are impacted, and repeat the analyses at the discretion of the field team leader.
- Remove the cap, and rinse the probes well with DI water. Blot the probes dry, carefully avoiding the DO membrane.

6.3.2 DO End-of-Day Check

- Follow the first step of the DO calibration in Section 5.3.1 above.
- Allow the DO % and temperature readings to stabilized for at least one minute. Record the number that appears on the screen. Record also the DO mg/L value.
- Check the oxygen solubility at that pressure and temperature on the attached Table 1 and record under "Std temp/pressure correction." The instrument DO reading should be comparable with the value on the table (within ±0.5 mg/L).

6.4 pH

The pH of a sample is determined electrometrically using a glass electrode. Choose the appropriate standards that will bracket the expected values at the sampling locations. A two or three-point calibration can be performed. Typically, a three-point calibration using standards pH 4, pH 7, and pH 10 will be required. A calibration check is performed immediately after calibration using the pH 7 standard and a criterion of ±0.05 pH units. A calibration check is also performed at the end of the day using the pH 7 standard and a criteria of 0.3 pH units.

6.4.1 pH Calibration

- Allow the buffered samples to equilibrate to the ambient temperature.
- Remove the calibration cap and clean all of the probes on the sonde with deionized water. Begin with pH 7.00. Wipe with Kimwipe and immerse all the probes in the 7.00 pH solution. Place enough pH 7.00 solution in the calibration cup to immerse the pH probe, reference junction, and thermistor. Return to calibration mode.
- Scroll to pH on the calibration menu. Select 3-pt calibration.
- Enter pH 7.00 when prompted for the first value, and press "enter".

- When value is stable for approximately 30 seconds, press enter, and record the number that appears on the screen. The display will indicate that the calibration has been accepted and will prompt the analyst to enter a second pH value.
- Remove probes from solution. Rinse with DI water, wipe carefully, and put all probes in solution pH 4.00. Make sure that there is enough pH 4.00 buffer to immerse the pH probe, reference junction, and thermistor.
- Enter pH 4.00 when prompted for the second pH solution, press “enter”.
- Allow at least one minute for temperature equilibration. When value is stable for at least 30 seconds, press “enter”, and record the number that appears on the screen.
- Repeat steps 5, 6, and 7 for the pH 10.00 solution.
- Press “enter” or “esc” to go to calibration menu.
- Go to the run mode to perform a calibration check of the pH 7.00 solution. Rinse the probe and immerse in pH 7.00 solution. The reading should be within ± 0.05 standard units of 7.00. If not, recalibrate. Record the reading.

6.4.2 pH End-of-Day Check

- Go to the run mode to perform a calibration check of the pH 7.00 solution.
- Rinse the probe and immerse in pH 7.00 solution. Record the reading. The reading should be within ± 0.3 standard units of 7.00.
- If not, record on the impacted measurements that the pH calibration check criterion was not met.

6.5 Conductivity

Conductivity is used to measure the ability of an aqueous solution to carry an electrical current. Specific conductance is the conductivity value corrected to 25°C. Note that the pH buffers are highly conductive and will adversely impact calibration of conductivity. Thoroughly rinse the probes after performing pH calibration, and then pre-rinse the probe with the conductivity solution to be used.

U.S. EPA recommends that conductivity be calibrated using standards that bracket the range of concentrations expected. Conductivities in groundwater frequently range below 1,000 µS/cm; however YSI does not recommend calibration with standards below 1,000 µS/cm because interference with the instrument from outside electrical noise (RF) may be a factor. Since the calibration for conductivity is a 1-point calibration, and expected conductivities will generally be less than 1,000 µS/cm, calibrate with the 1,000 µS/cm standard.

6.5.1 Conductivity Calibration

- Carefully rinse the probes in deionized water provided by the laboratory then in the first conductivity solution to be used.
- Immerse all probes completely in the conductivity calibration solution. Make sure that the thermistor is immersed, and the conductivity cell is immersed past the vent hole. Gently tap the side of the calibration cup to dislodge any air bubbles trapped inside the cell.
- Scroll to conductivity on the screen. Select calibrate to ms/cm. Check the standard solution on the temperature correction table (Table 1, below), or the table supplied with the bottle, and enter the corrected conductivity value. (Both should be in µs/cm.)
- Press “enter” and wait for the readings to stabilize. Press “enter”. Record the readings for conductivity and specific conductivity in the calibration log. Do not exit conductivity.
- Do not indicate “accept” when the calibration indicates “Out of Range.” Attempt to recalibrate. If the problem persists, use another instrument. Return the instrument to the vendor or equipment room.
- Perform a check of the calibration. Remove the probes from the solution. Rinse with the next conductivity solution. Immerse all probes in the conductivity calibration solution. Allow the number to stabilize and record the values for conductivity and specific conductivity in the calibration log. If the specific conductivity result is not within 5% of the value on the bottle, recalibrate. Remove probes from solution and rinse with DI water. Wipe dry.

6.5.2 Conductivity End-of-Day Check

- Rinse the probes with the conductivity solution then immerse all probes in the conductivity calibration solution.
- Allow the read out number to stabilize and record the values for conductivity and specific conductivity in the calibration log. If the specific conductivity result is not within 20% of the value on the bottle, note on the measurements obtained that the conductivity calibration check criteria were not met.
- Remove the probes from solution and rinse with DI water. Wipe dry.

6.6 Oxidation Reduction Potential

ORP will be checked for accuracy, and will only be field calibrated if the calibration check fails criteria.

6.6.1 ORP Calibration

- Switch to run mode. If not already pre-mixed, gently mix the ORP solution and open the packet. Put all but the DO probe in the ORP solution. Allow to stabilize and record reading. If reading is within ±10 millivolts (mV) of the actual value corrected for temperature (see table below), calibration is not required. If reading is not within ±10 mV of the actual value corrected for temperature (see table below), proceed to the next step below.
- Go to Calibration mode. Scroll to ORP and press “enter”. Enter ORP value (corrected for temperature - see above) and press “enter”. When the number is stable for 20 seconds, press “enter” and record the number. If instrument says “Out of Range,” do not accept the value: Use a different instrument. If a different instrument is not available, record the number and note that it is not within limits.

6.6.2 ORP End-of-Day Check

- Switch to run mode.
- Gently mix the ORP solution and open the packet. Put all but the DO probe in the ORP solution.
- Allow to stabilize and record reading. If reading is not within ±10 mV of the actual value corrected for temperature (see table below), note on the measurements affected that the criterion for ORP check was not met.

6.7 Instrument Shutdown

- Replace the storage cup with a wet sponge in the bottom over probes.
- Select run mode. Reset the parameters to the following:
  - pH
  - specific conductivity
  - ORP
  - Temperature
  - DO mg/L
  - Shut off hand held display and return to case

7.0 DATA & RECORDS MANAGEMENT

Calibration log sheets shall be used to document the details of instrument calibration and calibration checks.

The site logbook should be used to note when instrument calibration and instrument calibration checks were conducted, and should reference the calibration log sheets for details.

Readings measured by instruments that are subsequently found to be outside of criteria during the calibration check shall be documented on the sampling worksheet used to document the sample collection.

All field records will be maintained in the project files.

8.0 QUALITY ASSURANCE AND QUALITY CONTROL

8.1 Quality Control

Criteria are summarized in Table 3, which is attached..

8.2 Pollution Prevention

Containers used to calibrate the probes shall be sized to use the smallest amount of standard possible but still accommodate all probes which need to be in the calibration solution such that they are adequately covered.

Conductivity and pH calibration solutions may be reused at the end of the day with caution if properly stored. However, a calibration check that reuses standard but does not meet criteria should be re-checked with fresh standard, and calibration should be conducted with fresh standards.

8.3 Waste Management

Unused calibration standards should be returned to the equipment room manager or equipment rental vendor for proper disposal and/or storage. Do not combine ORP standards with other standards since cyanide could be released. Used calibration standards should be disposed of in accordance with *SOP EN-106 Investigative Derived Waste Management*.

Approved

9.0 REFERENCES

Enbridge, 2010. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Health and Safety Plan (HASP). August 2010.

SOP EN-106 – Investigative Derived Waste Management

YSI, Inc. (YSI). 2002. YSI Calibration Procedures: Profiling and Logging, www.water-monitor.com.

Table 1: Conductivity Temperature Corrections

Temperature, °C	100 µS/cm	1,000 µS/cm	10,000 µS/cm
5.0	--	700	7260
10.0	--	718	7437
11.0	--	736	7614
12.00	--	754	7793
13.0	--	773	7972
14.0	--	791	8153
15.0	82	814	8615
16.0	84	833	8800
17.0	85	852	8987
18.0	87	870	9175
19.0	89	889	9364
20.0	91	908	9555
21.0	93	927	9747
22.0	94	947	9941
23.0	96	966	10136
24.0	98	985	10332
25.0	100	1004	10530
26.0	102	1024	10730
27.0	104	1043	10930
28.0	106	1062	11132
29.0	108	1082	11336
30.0	110	1102	11541
31.0	112	1121	11748
32.0	114	1141	11955
33.0	116	1161	12165
34.0	119	1181	12375
35.0	121	1201	12588

Table 2: ORP Check Standard Readings

Temperature, °C	100 mV Standard Solution
10	124.4
15	116.7
20	109.1
25	100
30	93.1
35	84.9
40	76.3

Table 3: Quality Control Criteria

Parameter	Beginning of Activities				End-of-Day	
	Calibration		Calibration Check		Calibration Check	
	Standard	Criteria	Standard	Criteria	Standard	Criteria
Temperature	NIST Thermometer	± 0.15 °C	NA	NA	NA	NA
Dissolved Oxygen	100 % Saturated	± 0.2 mg/L	0.0 mg/L	< 1.0 mg/L	100% Sat	± 0.5 mg/L
pH	Bracket anticipated (pH 7.00, 4.00, 10.00)	NA	pH 7.00	± 0.05 pH	pH 7.00	± 0.3 pH
Conductivity	Bracket anticipated (≥ 1,000 µS/cm)	NA	Bracket anticipated	± 5%	Same as for calibration	± 20%
Oxidation-Reduction Potential	Only if check fails: 100 mV Zobell solution	NA	100 mV Zobell solution	± 10 mV	100 mV Zobell solution	± 10 mV

Approved

Enbridge Line 6B MP 608

Marshall, MI Pipeline Release

Photoionization Detector Measurement – SOP EN-503

Prepared for Michigan Department of Environmental Quality

Enbridge Energy, Limited Partnership

Approved: August 30, 2011

Approved

Approved

LIST OF ACRONYMS

eV	electron volts
HASP	Health and Safety Plan
PID	Photoionization Detector
PPE	Personal Protective Equipment
ppm	parts per million
QAPP	Quality Assurance Project Plan
UV	ultraviolet

Approved

1.0 SCOPE & METHOD SUMMARY

1.1 Purpose and Applicability

This Standard Operating Procedure (SOP) provides guidance for documentation of field activities associated with Enbridge Line 6B MP 608 Marshall, Michigan Pipeline Release (Project) operations, including, but not limited to; sample collection, field measurements, and groundwater monitoring well installation. This document describes the procedures that will be followed by field staff for operation and calibration of a photoionization detector (PID). The PID is primarily used by AECOM personnel for safety and survey monitoring of ambient air, determining the presence of volatiles in soil and water, and detecting leakage of volatiles.

PIDs routinely used by AECOM personnel include but are not limited to the Photovac Microtip, Thermoelectron 580EZ, MiniRAE 2000, OVM, and HNU. Personnel responsible for using the PID should first read and thoroughly familiarize themselves with the instrument instruction manual.

It is expected that the procedures outlined in this SOP will be followed. Procedural modifications may be warranted depending on field conditions, equipment limitations, or limitations imposed by the procedure. Substantive modification to this SOP will be noted in task-specific work plans or on Field Modification Forms as appropriate and will be approved in advance by the Task Manager. Deviations from the SOP will be documented in the project records and in subsequent reports.

1.2 Principle of Operation

The PID is a non-specific vapor/gas detector. The unit generally consists of a hand-held probe that houses a PID, consisting of an ultraviolet (UV) lamp, two electrodes, and a small fan which pulls ambient air into the probe inlet tube. The probe is connected to a readout/control box that consists of electronic control circuits, a readout display, and the system battery. Units are available with UV lamps having energy from 9.5 electron volts (eV) to 11.7 eV.

The PID analyzer measures the concentration of trace gas present in the atmosphere by photoionization. Photoionization occurs when an atom or molecule absorbs a photon of sufficient energy to release an electron and become a positive ion. This will occur when the ionization potential of the molecule (in eV) is less than the energy of the photon. The source of photons is an ultraviolet lamp in the probe unit. Lamps are available with energies ranging from 9.5 eV to 11.7 eV. All organic and inorganic vapor/gas compounds having ionization potentials lower than the energy output of the UV lamp are ionized and the resulting potentiometric change is seen as a positive reading on the unit. The reading is proportional to the concentration of organics and/or inorganics in the vapor.

Sample gases enter the probe through the inlet tube and enter the ion chamber where they are exposed to the photons emanating from the UV lamp. Ionization occurs for those molecules having ionization potentials near to or less than that of the lamp. A positive-biased polarizing electrode causes these positive ions to travel to a collector electrode in the chamber. Thus the ions create an electrical current which is amplified and displayed on the meter. This current is proportional to the concentration of trace gas present in the ion chamber and to the sensitivity of that gas to photoionization.

In service, the analyzer is first calibrated with a gas of known composition equal to, close to, or representative of that to be measured. Gases with ionization potentials near to or less than the energy of the lamp will be ionized. These gases will thus be detected and measured by the analyzer. Gases with ionization potentials greater than the energy of the lamp will not be detected. The ionization potentials of the major components of air, i.e., oxygen, nitrogen, and carbon dioxide, range from about 12.0 eV to 15.6 eV and are not ionized by any of the lamps available. Gases with ionization potentials near to or slightly higher than the lamp are partially ionized, with low sensitivity.

1.3 Specifications

Refer to the manufacturer’s instructions for the technical specifications of the instrument being used. The operating concentration range is typically 0.1 to 2,000 parts per million (ppm) isobutylene equivalent.

2.0 PERSONNEL QUALIFICATIONS

The Project Manager is responsible for ensuring that project-specific requirements are communicated to the project team and for providing the materials, resources, and guidance necessary to perform the measurements in accordance with this SOP and the project plan.

The field operator is responsible for verifying that the PID is in proper operating condition prior to use and for implementing the calibration and measurement procedures in accordance with this SOP and the project plan. Field staff will record all pertinent data into a digital capture device, onto a boring log or into a field logbook.

3.0 HEALTH AND SAFETY

The health and safety considerations for the work associated with this SOP, including both potential physical and chemical hazards, is addressed in the site specific *Health and Safety Plan (HASP)* (Enbridge, 2010). All work will be conducted in accordance with the HASP.

Site investigation activities may involve physical and/or chemical hazards associated with exposure to water, sediment, or materials in contact with either water or sediment. When sediment sampling is performed, adequate health and safety measures must be taken to protect field personnel. These measures are addressed in the project HASP.

4.0 INTERFERENCES

Regardless of which gas is used for calibration, the instrument will respond to all analytes present in the sample that can be detected by the type of lamp used in the PID.

Moisture will generate a positive interference in the concentration measured for a PID and is characterized by a slow increase in the reading as the measurement is made. Care must be taken to minimize uptake of moisture to the extent possible. Refer to the manufacturers' instructions for care, cleaning, and maintenance.

Uptake of soil into the PID must be avoided as it will compromise instrument performance by blocking the probe, causing a positive interference, or dirtying the PID lamp. Refer to the manufacturers' instructions for care, cleaning, and maintenance.

The user should listen to the pitch of the sampling pump. Any changes in pitch may indicate a blockage and corrective action should be initiated.

5.0 EQUIPMENT & SUPPLIES

The following equipment list contains materials which may be needed in carrying out the procedures contained in this SOP. Not all equipment listed below may be necessary for a specific activity. Additional equipment may be required, pending field conditions.

- Calibration Gas: Compressed gas cylinder of isobutylene in air or similar stable gas mixture of known concentration. The selected gas should have an ionization potential similar to that of the vapors to be monitored, if known. The concentration should be at 50-75% of the range in which the instrument is to be calibrated.
- Regulator for calibration gas cylinder,
- Approximately 6 inches of Teflon® tubing,
- Tedlar bag (optional),
- Commercially-supplied zero grade air (optional),
- Permanent marker,
- Battery charger,
- Moisture traps,
- Spare lamps,
- Manufacturer’s instructions,
- Field data sheets, logbook, and/or electronic data capture device,
- Pen with indelible ink, and
- Personal protective equipment (PPE) and health and safety equipment as specified in the HASP.

6.0 METHOD

6.1 Preparation

Preliminary steps (battery charging, check-out, calibration, maintenance) should be conducted in a controlled or non-hazardous environment.

6.2 Calibration

The PID must be calibrated in order to display concentrations in units equivalent to ppm. First a supply of zero air (ambient air or from a supplied source), containing no ionizable gases or vapors is used to set the zero point. A span gas, containing a known concentration of a photoionizable gas or vapor, is then used to set the sensitivity.

Turn on the unit and allow it to warm up (minimum of 5 minutes). Calibrate the instrument according to the manufacturer’s instructions. Record the instrument model and serial number, the calibration gas composition and concentration, and the date and the time of calibration in the field records.

If the calibration cannot be achieved or if the span setting resulting from calibration is 0.0, then the lamp must be cleaned (Refer to manufacturer’s instructions).

6.3 Operation

Turn on the unit and allow it to warm up (minimum of 5 minutes). Check to see if the intake fan is functioning; if so, the probe will vibrate slightly and a distinct sound will be audible when holding the probe casing next to the ear. Also, verify on the readout display that the UV lamp is lit.

If not already calibrated, calibrate the instrument as described in *Section 6.2*, following the manufacturer’s instructions. Record the calibration information in the field records.

The instrument is now operational. Readings should be recorded in the field records.

When the PID is not being used or between monitoring intervals, the unit may be switched off to conserve battery power and UV lamp life; however, a “bump” test should be performed each time the unit is turned on and prior to taking additional measurements. To perform a bump test, connect the outlet tubing from a Tedlar bag containing a small amount of span gas to the inlet tubing on the unit and record the reading. If the reading is not within the tolerance specified in the project plan, the unit must be recalibrated.

At the end of each day, recheck the calibration. The check will follow the same procedures as the initial calibration (*Section 6.2*) except that no adjustment will be made to the instrument. Record the information in the field records.

Recharge the battery after each use (*Section 6.4)*.

When transporting, ensure that the instrument is packed in its stored condition in order to prevent damage.

6.4 Routine Maintenance

Routine maintenance associated with the use of the PID includes charging the battery, cleaning the lamp window, replacing the detector UV lamp, replacing the inlet filter, and replacing the sample pump. Refer to the manufacturer's instructions for procedures and frequency.

All routine maintenance should be performed in a non-hazardous environment.

6.5 Troubleshooting

One convenient method for periodically confirming instrument response is to hold the sensor probe next to the tip of a magic marker. A significant reading should readily be observed.

Air currents or drafts in the vicinity of the probe tip may cause fluctuations in readings.

A fogged or dirty lamp, due to operation in a humid or dusty environment, may cause erratic or fluctuating readings. The PID should never be operated without the moisture trap in place.

Moving the instrument from a cool or air-conditioned area to a warmer area may cause moisture to condense on the UV lamp and produce unstable readings.

A zero reading on the meter should not necessarily be interpreted as an absence of air contaminants. The detection capabilities of the PID are limited to those compounds that will be ionized by the particular probe used.

Many volatile compounds have a low odor threshold. A lack of meter response in the presence of odors does not necessarily indicate instrument failure.

When high vapor concentrations enter the ionization chamber in the PID the unit can become saturated or “flooded”. Remove the unit to a fresh air environment to allow the vapors to be completely ionized and purged from the unit.

7.0 DATA & RECORDS MANAGEMENT

Safety and survey monitoring with the PID will be documented in a bound field logbook, on standardized forms, and/or in an electronic data capture device and retained in the project files. The following information is to be recorded:

- Project name and number,
- Instrument manufacturer, model, and identification number,
- Operator's name,
- Date and time of operation,
- Calibration gas used,
- Calibration check at beginning and end of day (meter readings before adjustment),
- Meter readings (monitoring data obtained),
- Instances of erratic or questionable meter readings and corrective actions taken, and
- Instrument checks and response verifications – e.g., battery check, magic marker response or similar test.

8.0 QUALITY ASSURANCE AND QUALITY CONTROL

The end use of the data will determine the quality assurance requirements that are necessary to produce data of acceptable quality. These quality assurance requirements will be defined in the site-specific work plan or *Quality Assurance Project Plan* (*QAPP*).

Calibration of the PID will be conducted at the frequency specified in the project plans. In the absence of project-specific guidance, calibration will be performed at the beginning of each day of sampling or health and safety monitoring and will be checked at the end of the day or whenever instrument operation is suspect. The PID will sample a calibration gas of known concentration. The instrument must agree with the calibration gas within ±10%. If the instrument responds outside this tolerance, it must be recalibrated.

Checks of the instrument response (*Section 6.5*) should be conducted periodically and documented in the field records.

Approved

9.0 REFERENCES

Enbridge, 2010. Enbridge Line 6B MP 608 Pipeline Release; Marshall, Michigan; Health and Safety Plan (HASP). August 2010.

Attachment B

Drinking Water Well Supplement to the Sampling and Analysis Plan

Approved

Enbridge Line 6B MP 608

Marshall, MI Pipeline Release

SAP Attachment B

Drinking Water Well Supplement to the Sampling and Analysis Plan

Prepared for Michigan Department of Environmental Quality

Enbridge Energy, Limited Partnership

Submitted: November 11, 2010

Approved: August 30, 2011

Figures

Approved

LIST OF ACRONYMS

DRO/GRO	Diesel/Gasoline Range Organics
Enbridge	Enbridge Energy, Limited Partnership
GIS	Geographic l Information Systems
MDEQ	Michigan Department of Environmental Quality
Order	Administrative Consent Order And Partial Settlement Agreement entered *In the Matter of Enbridge Energy Partners, L.P., and Enbridge Energy, Limited Partnership*, proceedings under the Michigan Natural Resources and Environmental Protection Act, 1994 PA 451, as amended, MCL 324.101 et seq. signed November 1, 2010
ORO	Oil Range Organics
PCBs	Polychlorinated Biphenyls
SAP	Sampling and Analysis Plan
SCRIBE	SCRIBE is a software tool developed by EPA to assist in the process of managing environmental data.
SVOCs	Semi-Volatile Organic Compounds
TOC	Total Organic Carbon
VOCs	Volatile Organic Compounds

Approved

1.0 Introduction

The Administrative Consent Order and Partial Settlement Agreement entered *In The Matter of Enbridge Energy Partners, L.P., and Enbridge Energy, Limited Partnership,* proceedings under the Michigan Natural Resources and Environmental Protection Act, 1994 PA 451, as amended, MCL 324.101 et seq. signed November 1, 2010 (Order) obligates Enbridge Energy, Limited Partnership (Enbridge) to perform response and restoration activities at and near the location of the release of heavy crude oil in Marshall, Michigan. This document presents a monitoring program for residential drinking water wells as a supplement to the *Sampling and Analysis Plan (SAP*) required under the Order.

This supplement summarizes the following procedures:

- Well determination(Section 2),
- Sampling of eligible wells (Section 3), and
- Reporting requirements (Section 4).

2.0 Determination of Eligible Wells

Wells within 200-feet of the high water levels observed during the July 27, 2010 rains (in accordance with the direction of the local Public Health Departments) on either side of the affected water bodies (*e.g.* Talmadge Creek, Kalamazoo River, and Morrow Lake) were classified as wells eligible for routine monitoring. Enbridge has completed the identification of wells within the 200-foot buffer. A geographical information system (GIS) based mapping system is used to track each parcel and each well identified.

Other sources of information were utilized to assist in locating wells, including:

- Township tax records for property owner names and addresses, and
- Electronic database searches.

The well identification process includes components of MDEQ's guidance document entitled *Decision Tree for Determining the Existence of Private Water Wells*.

A *Well Validation and Registry Work Order* form, included as *Figure 1* was used, and continues to be used, to document the collected information for each parcel and each well. The information on this form was collected on a handwritten form and/or was captured electronically on a field computer such as a Trimble Yuma®. The locations of the wells were plotted on maps based on coordinates recorded during the well determination process. Wells identified within 200-foot of the impacted area during a visual survey and wells obtained from agency-provided lists were sampled, pending approval from the well owners.

Approved

3.0 Sampling

3.1 Sample Event Scheduling

All owners/operators of the identified eligible wells were contacted in order to obtain permission to sample their respective wells. Permissions were documented on the *Well Sampling Work Order* form. An example of a typical form is included as *Figure 2*. *Well Validation door Hangers* were used to facilitate consistent interaction with owners and occupants. An example door hanger left when contact cannot be made is presented as *Figure 3*.

A *Well Sampling Work Order* will be produced for each property during each sampling event. All information including any changes in schedule or permissions will be documented on the form, captured electronically on a field computer such as a Trimble Yuma®, and documented in field notes. Door hangers will be used to notify owners and occupants that a sample has been collected. Examples of sampling door hangers left after residential well sampling are presented as *Figures 4* and *5*.

3.2 Sample Frequency

Wells will be sampled biweekly for the first two sample events at a residential well indicating no detected constituents related to crude oil. The sampling frequency will be reduced to once per month for three months and then continue on a quarterly basis thereafter. The Conceptual Site Model for groundwater flow currently holds that groundwater flow is toward the Kalamazoo River for most of the length of the river, and that hazardous constituents are not leaching into the ground based upon monitoring data. As this Conceptual Site Model is further refined and tested through the collection of additional data, and as more results are available from this monitoring program, Enbridge may petition the MDEQ for reductions in sampling frequency. No changes to sampling frequency will occur without further approval from the MDEQ.

Approved

3.3 Sample Parameters

Wells will be sampled for the following parameters once transferred to the monthly or quarterly sampling frequency:

Volatile Organic Compounds (VOCs)
Benzene
Ethylbenzene
Total Xylenes
Toluene
1,2,3-Trimethylbenzene
1,2,4-Trimethylbenzene
1,3,5-Trimethylbenzene
Cyclohexane
Isopropylbenzene
n-Propylbenzene
p-Isopropyl toluene
Sec-Butylbenzene
Metals
Mercury
Beryllium
Iron
Molybdenum
Nickel
Titanium
Vanadium
Semi-Volatile Organics (SVOCs)
2-Methylnapthlane
Naphthalene
Phenanthrene

Wells sampled on a bi-weekly basis will be sampled for the parameters listed above in addition to Diesel/Oil Range Organics (DRO/ORO), Gasoline Range Organics (GRO), Total Organic Carbon (TOC), and Polychlorinated Biphenyls (PCB).

4.0 Reporting Requirements

Enbridge will report the following well water information on a periodic basis to the agencies identified by the MDEQ.

- Enbridge will prepare a map and spreadsheet detailing the location of the wells and indicating whether or not the well was sampled less than two times or two times or more, wells where crude oil constituents were detected, and other applicable information. This information will be updated periodically and will be available for review by the agency. This information will be updated on a weekly basis.
- The results of the analyses will be provided to the landowner within approximately 7 days of receiving validated data. Additionally, the validated results will be provided to the appropriate County Health Department at the time that the results are distributed to the landowner or at a coordinated time arranged with each Health Department.
- Enbridge will provide to the MDEQ, and the local public health agencies, a summary of the locations of the wells sampled at the end of each day sorted by county, or at a schedule agreed to with each county.
- Data will be added to a SCRIBE project routinely and will be updated as samples are collected and validated data is received. Local project data will be uploaded to scribe.net.

Figure 1. Parcel Validation Form

Well Validation and Registry Work Order [2010]

PROPERTY

PROPERTY ID	WATER SUPPLY	WELLS ?	ELIGIBLE	ELIGIBILITY BASIS	PROPERTY TYPE	SURVEYORS NAME(S)
«property_no»	□CITY □WELL □BOTH □UKNOWN	□YES □NO □UKNOWN	□YES □NO □UKNOWN	□Parcel Location □Well Location □Owner/Occupant □Neighbor Interview □OTHER	□RESIDENCE □LOT □BUSINESS □OCCUPIED □VACANT	

PROPERTY CONTACT INFO		OWNER CONTACT INFORMATION
FULL NAME	«propertiesoccupant_name»	«owner_name»
ADDRESS	«property_house_number» «property_street_name»«property_city»	«owner_address_1»
CITY, STATE ZIP	«property_city» «propety_state» «property_zip»	«owner_city» «owner_state» «owner_zip»
PHONE #	«property_phone»	«owner_phone»

WORK ORDER

ID	APPT INFO	VISIT DATE	OCCUPANT STATUS	NAME OF INDIVIDUAL CONTACTED DURING SITE VISIT & RELATION TO OWNER
«ID»	«appointment_typ e» «window_start» «window_end»		□ AT HOME & MET □ AT HOME & NOT MET □ NOT HOME □ NOT APPLICABLE	

LEFT DOOR HANGER OR MESSAGE	RECOMMENDED ACTION	ACTION DATE	ACTION TIME
□ YES □ NO	□REVISIT FOR REGISTRY □VISIT FOR SAMPLING □DO NOT REVISIT □REMOVE PROPERTY NOT CLOSE		

PERMISSIONS	PROPERTY NOTES, COMMENTS, DIRECTIONS, OR SAFETY CONCERNS
□UNATTENDED PERMISSION, ANYTIME □UNATTENDED PERMISSION, RESTRICTED TIMES □PERMIT BUT CALL/SCHEDULE FIRST □REFUSED PERMISSION	«property_notes»

WELL 1

WELL (1) LOCATION DESCRIPTION	WELL TYPE	RIVER PROXIMITY	PROXMITY METHOD
	□ HOUSEHOLD □ IRRIGATION □ TESTING □ CLOSED	□ WITHIN 200FT □ BEYOND 200FT □ APPX. WITHIN 200FT □ UNKNOWN	□ OWNER/RESIDENT CLAIMED □ FIELD OBSERVATION □ FIELD MEASURED □ GIS SURVEY

SPIGOT (1) LOCATION DESCRIPTION	WATER CONDITIONER	CONDITIONER LOCATION
	□ YES □ NO □ UNKOWN	□ BEFORE SPIGOT □ AFTER SPIGOT □ UNKOWN

WELL (1) LATITUDE	WELL (1) LONGITUDE	SIERA TAKEN?	MEASUREMENT DEVICE
N __ __ . __ __ __ __ __ __	W - __ __ . __ __ __ __ __ __	☐ Yes ☐ No	

WELL (1) PERMIT #	WELL(1) DEPTH FEET	WELL (1) CASING DEPTH FEET	DRILL COMPANY

WELL 2

WELL (2) LOCATION DESCRIPTION	WELL TYPE	RIVER PROXIMITY	PROXMITY METHOD
	□ HOUSEHOLD □ IRRIGATION □ TESTING □ CLOSED	□ WITHIN 200FT □ BEYOND 200FT □ APPX. WITHIN 200FT □ UNKNOWN	□ OWNER/RESIDENT CLAIMED □ FIELD OBSERVATION □ FIELD MEASURED □ GIS SURVEY

SPIGOT (2) LOCATION DESCRIPTION	WATER CONDITIONER	CONDITIONER LOCATION
	□ YES □ NO □ UNKOWN	□ BEFORE SPIGOT □ AFTER SPIGOT □ UNKOWN

WELL (2) LATITUDE	WELL (2) LONGITUDE	SIERA TAKEN?	MEASUREMENT DEVICE
N __ __ . __ __ __ __ __ __	W - __ __ . __ __ __ __ __ __	☐ Yes ☐ No	

WELL (2) PERMIT #	WELL(2) DEPTH FEET	WELL (2) CASING DEPTH FEET	DRILL COMPANY

Data Entry by: _________ Data Entry Date: _________ QC by: _________ QC Date: _________

Figure 2. Well Sampling Form

Well Sampling Work Order | [2010]

PROPERTY

PROPERTY & WELL ID	PROPERTY CONTACT INFO		OWNER CONTACT INFORMATION
«property_no»	FULL NAME	«propertiesoccupant_name»	«owner_name»
	ADDRESS	«property_house_number» «property_street_name»	«owner_address_1»
«well_no»	CITY, STATE ZIP	«property_city», «propety_state» «property_zip»	«owner_city», «owner_state» «owner_zip»
	PHONE #	«property_phone»	«owner_phone»

WORK ORDER

ID	APPT INFO	VISIT DATE	OCCUPANT STATUS	WORKER 1 NAME	WORKER 2 NAME
«ID»	«appointment_type» «window_start» «window_end»		□ AT HOME & MET □ AT HOME & NOT MET □ NOT HOME □ NOT APPLICABLE		

LEFT DOOR HANGER OR MESSAGE	SAMPLE OUTCOME	RECOMMENDED ACTION	ACTION DATE	ACTION TIME
□ YES □ NO	□ PERFORMED WITHOUT OCCUPANT □ PERFORMED WITH OCCUPANT □ NOT PERFORMED	□REVISIT FOR SAMPLING – MISSED VISIT □REVISIT IN 2 WEEKS - ROUTINE □DO NOT REVISIT		

PERMISSIONS	PROPERTY NOTES, COMMENTS, DIRECTIONS, OR SAFETY CONCERNS
	«property_notes»

WELL

SPIGOT LOCATION DESCRIPTION	WATER CONDITIONER	CONDITIONER LOCATION
«spigot_location»	«water_conditioner»	«water_conditioner_location»
WELL LOCATION DESCRIPTION	**RIVER PROXIMITY**	**RIVER PROXMITY METHOD**
«well_location»	«river_proximity»	«river_proximity_method»

WELL PERMIT #	WELL DEPTH FEET	WELL CASING DEPTH FEET	WELL TYPE
«permit_number»	«well_depth_ft»	«casing_depth_ft»	«well_type»

WELL LATITUDE	WELL LONGITUDE	SIERA TAKEN?	
N __ __ . __ __ __ __ __ __	W - __ __ . __ __ __ __ __ __	☐ Yes ☐ No	

SAMPLING INFORMATION

SAMPLE DATE (MMDDYY)	PURGE START (24HRS)	SAMPLE TIME (24HRS)	SAMPLE ID

AGENCY PRESENT (OR N/A)	AGENT NAME	SPLIT SAMPLE	SPLIT SAMPLE ID
		□ Yes □ No	

ADDITIONAL SAMPLE	ADDITIONAL SAMPLE IDS
□ Yes □ No	

ANALYSES	NUMBER OF CONTAINERS	PRESERVATIVES	
□DRO/ORO (Diesel/Oil Range Organics)	□ 2	□ None	
□GRO (Gasoline Range Organics)	□ 2	□ HCl	
□TAL Metals	□ 1	□ HNO_3	
□VOCs (Volatiles Organic Compounds)	□ 2	□ Ascorbic Acid	□ HCL Added
□SVOCs (Semi-Volatile Organic Compounds)	□ 2	□ Sodium Thiosulfate	□ HCL Added
□PCBs (Poly Chlorinated Biphenyls)	□ 2	□ Sodium Thiosulfate	
□TOC	□ 2	□ Phosphoric Acid	

ADDITIONAL COMMENTS AND RESIDENT REQUESTS (INCLUDE WELL LOCATION ON PROPERTY)

Data Entry by: _________ Data Entry Date: _________ QC by: _________ QC Date: _________

Figure 3. Well Validation Door Hanger

SORRY WE MISSED YOU!

Dear Resident,

Per the Environmental Protection Agency's directive related to clean-up efforts of the oil spill, Enbridge has retained AECOM to identify, sample, and analyze water from all wells within areas which may be affected.

An AECOM representative would like to meet with you to determine if you have wells and if they are eligible for testing.

Please call Enbridge at 1-800-306-6837 to coordinate a revisit.

Should your well qualify for testing and analysis, the results will be provided to the property owner and the County Health Department at *no cost to you.*

Enbridge is dedicated to the environmental health and safety of the local residents. We thank you in advance for your cooperation.

ENBRIDGE

Figure 4. Bi-weekly Sampling Notice Door Hanger

Dear Resident,

Per the Environmental Protection Agency's directive related to clean-up efforts of the oil spill, Enbridge has retained AECOM to identify, sample, and analyze water from all wells within areas which may be affected.

An AECOM representative visited your property and collected a sample of your well water. The sample will be shipped to a certified drinking water laboratory and then sent to an independent data validator for review. The results will be delivered to property owner and the Health Department within approximately 18 business days.

Please call Enbridge at 1-800-306-6837 with any questions or concerns.

Enbridge is dedicated to the environmental health and safety of the local residents. We thank you in advance for your cooperation.

Date: ______________________________________
(Sample Collection Date)

Property No: ______________________________________
(Property ID)

Sample No: ______________________________________
(Sample ID)

ENBRIDGE

Figure 5. Monthly and Quarterly Sampling Notice Door Hanger

Dear Resident,

Per the Environmental Protection Agency's directive related to clean-up efforts of the oil spill, Enbridge has retained AECOM to identify, sample, and analyze water from all wells within areas which may be affected.

An AECOM representative visited your property and collected a sample of your well water. The sample will be shipped to a certified drinking water laboratory and then sent to an independent data validator for review. The results will be delivered to the property owner and the Health Department within approximately 30 business days.

Please call Enbridge at 1-800-306-6837 with any questions or concerns.

Enbridge is dedicated to the environmental health and safety of the local residents. We thank you in advance for your cooperation.

Date: ____________________________________
(Sample Collection Date)

Property No: ___________________________________
(Property ID)

Sample No: ____________________________________
(Sample ID)

ENBRIDGE

Attachment C

Surface Water and Sediment Monitoring Supplement to the Sampling and Analysis Plan

Approved

Enbridge Line 6B MP 608 Pipeline Release near Marshall, Michigan

SAP Attachment C

Surface Water and Sediment Monitoring Supplement to the Sampling and Analysis Plan

Prepared for Michigan Department of Environmental Quality

Enbridge Energy, Limited Partnership

Submitted: November 11, 2010

Approved: August 30, 2011

Approved

TABLES

FIGURES

Approved

LIST OF ACRONYMS

Enbridge	Enbridge Energy, Limited Partnership
Line 6B	The pipeline owned by Enbridge Energy, Limited Partnership that runs just south of Marshall, Michigan
MDEQ	Michigan Department of Environmental Quality
Order	Administrative Consent Order And Partial Settlement Agreement entered *In the Matter of Enbridge Energy Partners, L.P., and Enbridge Energy, Limited Partnership*, proceedings under the Michigan Natural Resources and Environmental Protection Act, 1994 PA 451, as amended, MCL 324.101 et seq. signed November 1, 2010
O&M	Operation and Maintenance
QAPP	Quality Assurance Project Plan
SAP	Sampling and Analysis Plan
SCRIBE	SCRIBE is a software tool developed by EPA to assist in the process of managing environmental data
SOP	Standard Operating Procedure
SVOC	Semi-Volatile Organic Compound
U.S. EPA	United States Environmental Protection Agency
U.S. EPA SAP	Sampling and Analysis Plan approved for work directed by the U.S. EPA
VOC	Volatile Organic Compound

Approved

1.0 INTRODUCTION

On November 1, 2010, Enbridge entered into a voluntary Administrative Consent Order and Partial Settlement Agreement with the Michigan Department of Environmental Quality (MDEQ) that obligates Enbridge to perform response and restoration activities at and near the location of the release of heavy crude oil in Marshall, Michigan (Order). This document presents a monitoring program for surface water and sediment as a supplement to the *Sampling and Analysis Plan (SAP)* required under the Order.

The objective for this surface water and sediment monitoring program supplement is to evaluate the surface water and sediment quality in the Kalamazoo River which was potentially impacted by the Line 6B release. The contents of the sampling program are modified from the previous sampling program approved by the United States Environmental Protection Agency (U.S. EPA) with input from other cooperating governmental agencies. The sampling locations and frequency have been modified from the October 22, 2010 memorandum from Steve Wolfe (U.S. EPA) and Brian Schlieger (U.S. EPA) to Ralph Dollhopf (U.S. EPA). Consistency with the formerly approved sampling program will allow continued evaluation of water and sediment quality trends since the release. The modified scope of this supplement is reflective of the results of the previous year-long monitoring program.

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2.0 DESCRIPTION OF SAMPLING

Sampling of surface water will continue to be performed at the existing sampling locations along the Kalamazoo River. Surface water samples will also be collected at existing locations in Morrow Lake. Sediment sampling will continue at select monitoring locations with a history of screening criteria exceedances.

2.1 Sample Location and Frequency

Sample location and frequency are presented in *Table 1* and sample locations are shown in *Figure 1*. These sampling locations are consistent with the revised SAP dated August 17, 2010, approved by the U.S. EPA (U.S. EPA SAP), which ensures continuity of the data set. Each sample location consists of at least one of the following characteristics:

- The sample location is adjacent to a current or decommissioned operation and maintenance (O & M) control point. These control points temporarily collected and/or stored waste generated from release activities.
- The sample location is in Morrow Lake.
- The sample location is between the release and Morrow Lake at 2 mile intervals, and was part of the U.S. EPA SAP.
- One sample location is immediately downriver of Morrow Lake (SW-112).

Sample location SW-112 was included to monitor potential impact to the Kalamazoo River beyond Morrow Lake. An additional location (SW-128) was included as a contingency in the event that impact was observed at SW-112.

Sample locations in the Kalamazoo River are collected from the riverbank. Sample locations in Morrow Lake are collected from a boat with the exception of the Morrow Lake Dam (SWKR3980C01) and the shore near the boat launch (SW-111).

Surface water and sediment sampling will be performed in accordance with the Standard Operating Procedures (SOPs) presented in Appendix A of this SAP, including *SOP EN-201 - Surface Water Sample Collection* and *SOP EN 202 - Sediment Sample Collection*.

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2.2 Sampling During Winter Months

Winter weather will cause the surface of Morrow Lake and the Kalamazoo River to freeze in places, significantly increasing safety risks for workers performing sample collection. Sample collection may be discontinued due to adverse winter conditions.

2.2.1 Riverbank Sampling

Each sample location will be evaluated by the sample team to determine if a sample may be collected safely. The sample team will not attempt to walk on ice or snow that may cover surface water, or wade to access a sampling point.

2.2.2 Boat Sampling

Boat sampling will be discontinued when ice forms on Morrow Lake. Temporary stand down of sampling activities may be required as weather permits and/or as directed by Enbridge or a site safety professional. Boat safety issues such as rapid currents and floating debris will be evaluated on a situational basis by a safety professional.

2.3 Sample Analysis

Surface water and sediment samples will be analyzed for the following parameters using the analytical procedures identified in the *Quality Assurance Project Plan (QAPP)*:

Target Analytes	Optional Parameters mg/L
VOCs	Calcium
SVOCs	Magnesium
Beryllium	Potassium
Molybdenum	Sodium
Vanadium	Carbonate Alkalinity (as CaCo3)
	Bicarbonate Alkalinity (as CaC03)
	Chloride
	Sulfate

Approved

3.0 REPORTING

Surface water and sediment sampling analytical results will be uploaded to SCRIBE.

		Sample ID	Latitude	Longitude	Notes	Location Discussion	Surface Water Sample (1 per month)	Sediment Sample (1 per quarter)
Locations next to O&M control point		SW-105	42.25825	-84.998184	Existing location	MP 2.1 - Talmadge & Kalamazoo	1	0
		SWKR0540C01	42.266558	-85.054032	October 2010 O&M monitoring pt.	MP 5.4 O&M Control Point	1	0
		SWKR0600C01	42.270887	-85.063948	October 2010 O&M monitoring pt.	MP 6.0 O&M Control Point	1	1
		SW-117[a]	42.304726	-85.183417	October 2010 O&M monitoring pt.	MP 14.8 O&M Control Point	1	0
		SWKR1565C01	42.312748	-85.184869	October 2010 O&M monitoring pt.	MP 15.5 O&M Control Point	1	1
		SWKR1948C01	42.343617	-85.243147	October 2010 O&M monitoring pt.	MP 19.4 O&M Control Point	1	0
		SW-120	42.347423	-85.329214	Existing location	MP 27 O&M Control Point	1	0
		SW-115	42.324341	-85.358049	Existing location	MP 29.4 O&M Control Point	1	0
		SW-110	42.280206	-85.429028	Existing location	MP 35.2 O&M Control Point	1	0
	Locations in Morrow Lake	SWKR3980C01	42.282665	-85.491508	Morrow Lake	MP 39.75 O&M Control Point	1	0
		SW-111	42.278248	-85.452362		Morrow Lake	1	0
		SW-935	42.278255	-85.472069	West Buoy	Morrow Lake	1	0
		SW-936	42.276611	-85.453972	East Buoy, near inlet	Morrow Lake	1	0
		SW-937	42.2812	-85.486115	Node 109, near dam	Morrow Lake	1	1
		ML-1	42.279011	-85.458466	SW-939/Node 107	Morrow Lake	1	0
		ML-2	42.279224	-85.455406		Morrow Lake	1	0
		ML-3	42.277012	-85.4571		Morrow Lake	1	0
		ML-4	42.27417	-85.460007		Morrow Lake	1	0
	Locations in Morrow Lake	ML-5	42.274372	-85.456184		Morrow Lake	1	0
		ML-6	42.282177	-85.486198		Morrow Lake	1	0
		ML-7	42.281063	-85.480469		Morrow Lake	1	0
		ML-8	42.279621	-85.482033		Morrow Lake	1	0
		ML-9	42.276756	-85.483139		Morrow Lake	1	0
		ML-10	42.276375	-85.47892		Morrow Lake	1	0
		SWKR3840C01	42.277886	-85.464807	October 2010 new location	Morrow Lake	1	0
		SWKR3840C02	42.274991	-85.464724	October 2010 new location	Morrow Lake	1	0

		Sample ID	Latitude	Longitude	Notes	Location Discussion	Surface Water Sample (1 per month)	Sediment Sample (1 per quarter)
Down		SW-112	42.283659	-85.498262	First downstream location	Downstream from Morrow Lake	1	0
		SW-128	42.285886	-85.513624	Contingent second downstream	Downstream from Morrow Lake	0	0
	[a]	Location SW-117 was identified as SWKR1480C01 in the October 24, 2010 response to U.S. EPA's October 22, 2010 memo.						

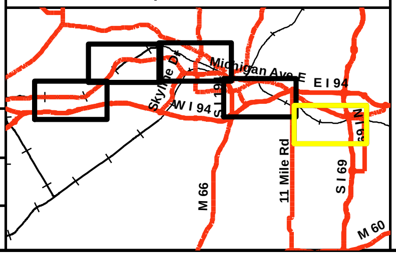
ENBRIDGE

Drawn: NS 08/23/2011

Approved:

Project #: 60162778

Map Location



Legend

Surface Water Sampling Location

- Downstream of Morrow Lake
- Morrow Lake
- Morrow Lake/Next to O&M Control Point
- Next to O&M Control Point

- Sediment Monitoring Location
- Quarter Mile Grid Segments

N

0 1,000 2,000 4,000

Scale in Feet

SURFACE WATER AND SEDIMENT SAMPLING LOCATIONS
Page 1 of 5

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
ENBRIDGE ENERGY, LIMITED PARTNERSHIP

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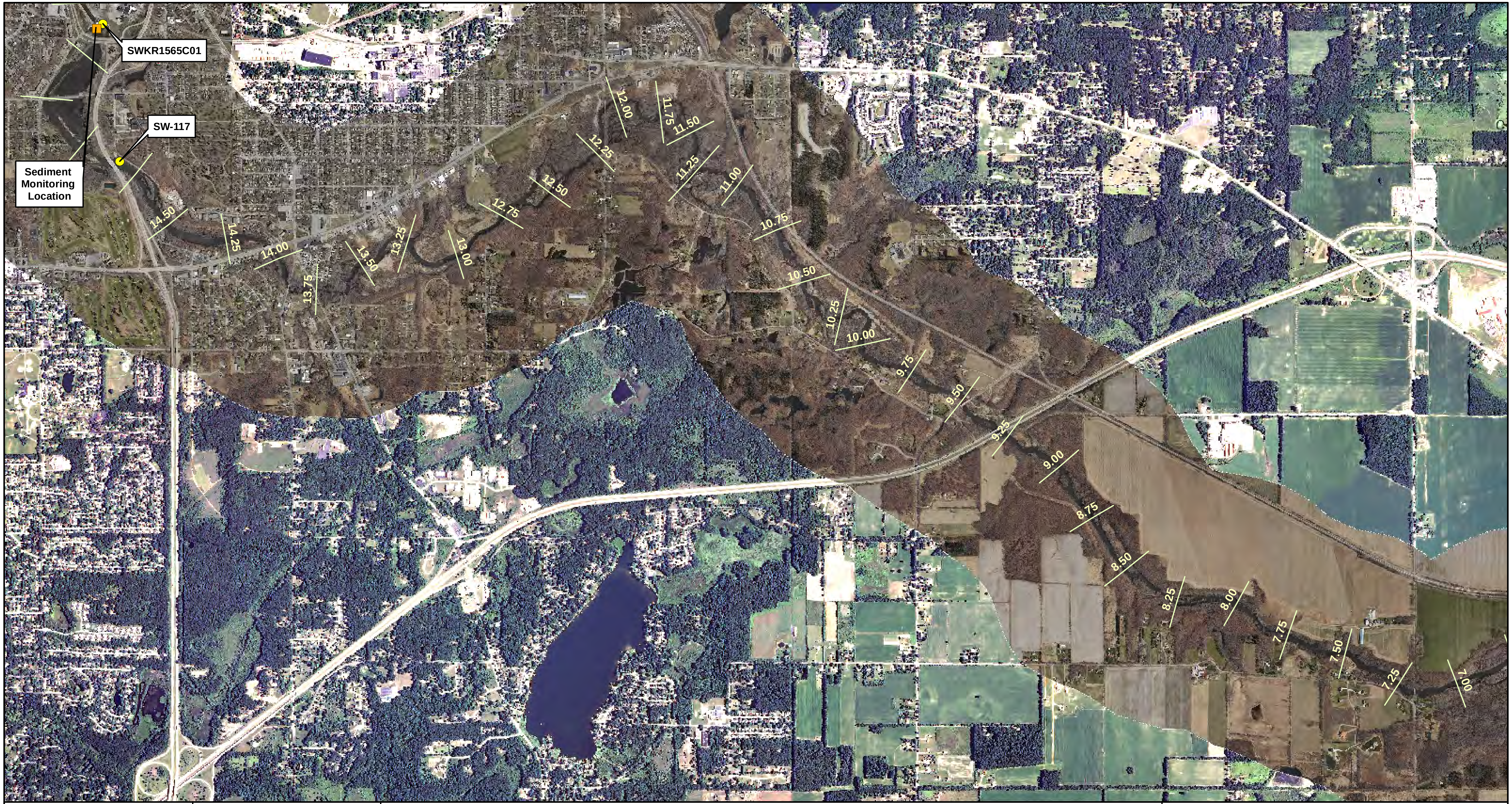
Aerial Photography Date: April 2011 over 2010 County Aerial



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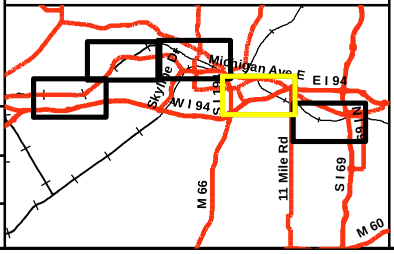

Legend

Surface Water Sampling Location

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- Morrow Lake
- Morrow Lake/Next to O&M Control Point
- Next to O&M Control Point

Sediment Monitoring Location

Quarter Mile Grid Segments

N

0 1,000 2,000 4,000

Scale in Feet

SURFACE WATER AND SEDIMENT SAMPLING LOCATIONS
Page 2 of 5

ENBRIDGE LINE 6B MP 608
MARSHALL, MI PIPELINE RELEASE
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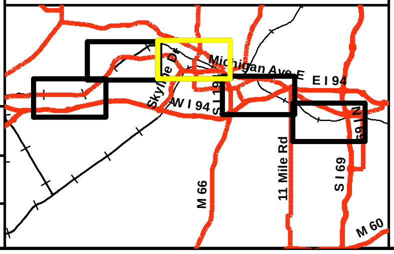

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Sediment Monitoring Location

Quarter Mile Grid Segments

N

0 1,000 2,000 4,000

Scale in Feet

SURFACE WATER AND SEDIMENT SAMPLING LOCATIONS
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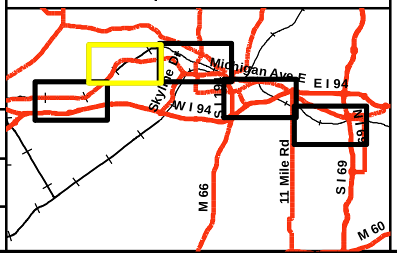

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Sediment Monitoring Location

Quarter Mile Grid Segments

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0 1,000 2,000 4,000

Scale in Feet

SURFACE WATER AND SEDIMENT SAMPLING LOCATIONS
Page 4 of 5

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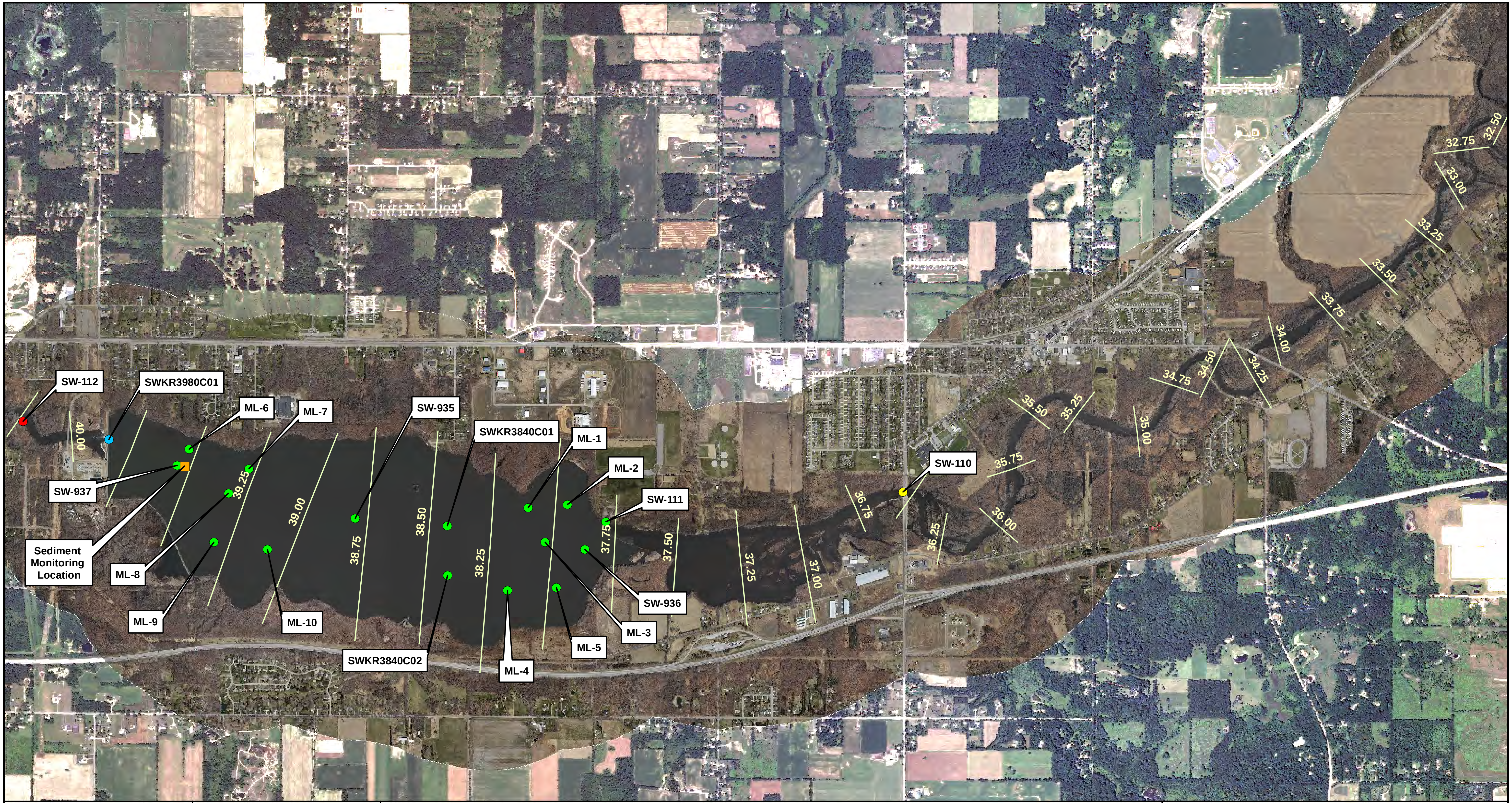

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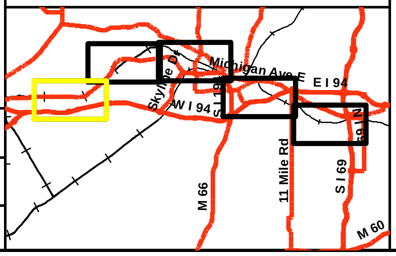

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